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PRACTICAL ASPECTS OF THE PROBLEM OF HYDRODYNAMIC BREAKAGE OF BOTTLES

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Editor's Note: The following paper is a condensed version of a lecture given at a joint meeting of the Physical Society of Pittsburgh and the Pittsburgh Section of the American Ceramic Society. The experimental program described in this paper was sponsored in part by the Glass Container Manufacturers Institute.

The breakage of bottles due to hydrodynamic action of the contents was first called to the attention of the industry by T. C. Baker of Hartford-Empire Company in a paper before the Glass Division of the American Ceramic Society at Cambridge Springs in the fall of 1941. This paper was printed in THE GLASS INDUSTRY[1] and still remains the classic on the subject. Very little more has been published since then, although the problem has increased in seriousness and extent. Neither the original work of Baker nor that of subsequent investigators has shown a simple, practical solution.

The present investigation has been no more successful than its predecessors in unearthing a cure-all. It has, however, given us a somewhat better insight into the motion of a bottle and its contents during hydrodynamic action and some knowledge of the roles of the various factors which might reasonably be expected to influence its occurrence and intensity.

Hydrodynamic action (or water hammer as it is better known to the glass industry) can perhaps best be demonstrated by grasping a bottle of catsup firmly in one hand and striking it on the cap with the other. If you do so, you will hear a sharp high-pitched click which is distinct from the thud of the original blow. This click is the impact of the water hammer on the inside of the bottle.

This impact is produced as follows: When the bottle is struck it moves sharply downward. The content, momentarily left behind, moves into the head space, producing cavities which are sometimes against the lower interior surface of the bottle and sometimes in the body of the content itself. When the bottle begins to lose its downward velocity the content returns to its initial position, violently collapsing the cavities. If a cavity is in the body of the fluid all is well. If, however, it is against the wall of the bottle (as is often the case), the bottle is dealt a substantial internal impact which may knock a hole through the lower sidewall. The most typical form of such a fracture is termed a "mouse hole" and has the appearance that the name suggests. If the bottle is abraded on the outside opposite the cavity, there may take place a very substantial weakening comparable to that observed for external impact in the presence of abrasions on the inside surface.

For the purpose of our studies a velocity pick-up was fixed to the base of the bottle and the output of this pick-up run through a differentiating circuit to give a voltage proportional to the acceleration of the bottle. When this voltage was applied to a cathode ray oscilloscope, a plot of the acceleration of the bottle bottom vs. time was obtained.

Fig. 1 is a reproduction of a photograph of the oscilloscope showing such a plot for a bottle of catsup during water hammer. The first downward peak is the acceleration produced by the initial blow, the upward peak is the reaction of the restraint in stopping the bottle, and the second, sharp, downward peak is the shock delivered the bottle by the content on the collapse of the cavity.

The pick-up was so made that it could be mounted on a bottle in a carton, and tests were conducted to study the accelerations encountered by a bottle in trade handling. It was found, if two cartons were stacked and a third dropped on them, that violent hydrodynamic action could be produced in the center carton. A tester was built which reproduced this action in a single bottle and further studies were made on this tester. Fig. 2 is a photo-

[1] Baker, T. C., "Water Hammer Breakage of Glass Containers," THE GLASS INDUSTRY, Vol. 22; No. 10, 430; No. 11, 469; No. 12, 521 (1941).

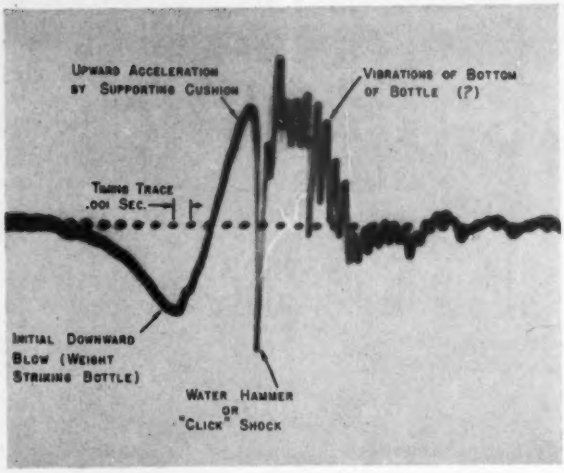
Upward Acceleration by Supporting Cushion
Vibrations of Bottom of Bottle (?)
Timing Trace .001 Sec.
Initial Downward Blow (Weight Striking Bottle)
Water Hammer or "Click" Shock

Fig. 1. Photograph of oscilloscope trace showing acceleration vs. time for a bottle supported beneath and cushioned above with rubber cushions and struck by a 2 lb. weight dropped 5¾ inches. This trace is similar to that obtained for motion of bottles in cartons in stacked-carton drop test.

graph of this tester showing the oscilloscope and allied electrical equipment.

Effect of Head Space Pressure

In the course of these studies it was discovered that there is a definite threshold value of jolt or blow which will produce the hydrodynamic click and the sharp peak on the oscilloscope trace. This threshold decreases as the head space vacuum is increased. In other words, the higher the vacuum the easier it is to produce water hammer. However, as the vacuum is decreased (head space pressure increased), water hammer shock increases more rapidly with increasingly severe initial blows. This produces the anomalous situation that if the jolt to be given the bottle is relatively mild, increasing head space vacuum increases the danger of hydrodynamic breakage, while for very severe jolts increasing head space vacuum decreases the danger of breakage. In practice most bottles will break before the very severe jolt is reached so that a low vacuum (high head space pressure) is generally a practical advantage. Fig. 3 summarizes the situation and contains curves which were compiled from a large body of data gathered during the experiment. The value of water hammer shock as recorded in the figure is that obtained from measurements of the amplitude of the click peak on the oscilloscope acceleration traces.

Effect of Carton Cushioning

The amount of cushioning above the bottle was found to have a relatively small effect on the magnitude of hydrodynamic shock. It was discovered that, while doubling the cushioning above the bottle produces some decrease in the shock, the gain is relatively small. Since this added cushioning is equivalent to four thicknesses of corrugated board there seems to be little hope for a practical solution in this direction.

This result was confirmed in breakage tests conducted by dropping one carton on two others from increasing heights and using the level of first breakage as a criterion of resistance to hydrodynamic breakage. Here we detected no significant difference between cartons with no pads and cartons with one pad above and one below the bottle.

Effect of Gas Trapped in Contents

The next factor studied was the effect of entrapped gas in the product. It had been observed that if a bottle of catsup were inverted and shaken vigorously it then became almost impossible to produce a sharp hydrodynamic click from it. This was thought to be caused by head space gas becoming trapped in the catsup and acting as a cushion for the shock.

Sample bottles from several lots of catsup were tested for trapped air content and the remaining bottles broken in the stacked-carton drop test. The water hammer resistance was found to correlate closely with the gas content, the catsups with a high gas content being markedly less susceptible to breakage. The results of this test are summarized in Fig. 4. Of the factors studied this seemed most promising as a solution to the problem. If all catsups and similar semi-fluid products could be packed with a reasonable amount of air or other gas (1.5 to 2 cc. at 25 in. of vacuum for a 14 oz. catsup bottle) trapped in the contents, it seems almost certain that hydrodynamic breakage would be greatly reduced if not eliminated altogether. This, however, seems a vain hope since the presence of air is considered undesirable, and more and more efficient deaeration techniques are likely to intensify the trouble rather than otherwise.

Fig. 2. Tester to reproduce in-carton motion on single bottle of catsup. The velocity pick-up is mounted beneath the platform which supports the bottle. The 2 lb. weight is suspended in the vertical tube and is released by an electrically activated tripping device. The switch at the base of the tube synchronizes the oscilloscope with the impact.

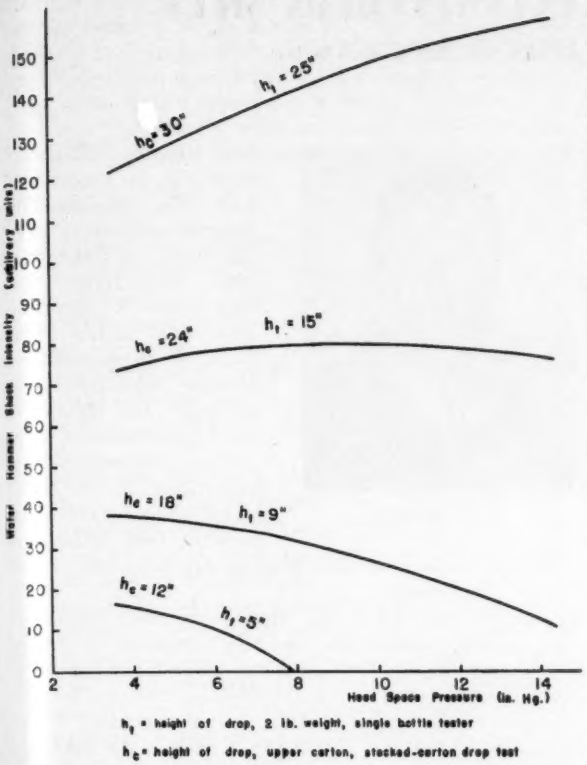

Fig. 3. Relation of water hammer intensity to head space pressure at constant intensity of initial blow. The lowest curve ($h_C = 12$ in.) is at the level at which the most susceptible packs begin to give breakage in the stacked-carton drop test.

Other Factors

The formation and collapse of a cavity in a semi-fluid product is an extremely complex and subtle phenomenon, and other contributing factors were observed during our investigation. Thus the presence, type and distribution of pulp in the product is important in determining its tendency to misbehave. A thorough investigation of this effect would, however, have led us far afield into the domain of food technology and was decided not to be worth while since in practical application these factors are not amenable to control, at any rate by the manufacturers of bottles.

The only other factor studied which holds any promise of reducing breakage is the shipping of catsup with the bottles inverted in the cartons. In the carton drop tests, the level of first breakage was approximately twice as high for most lots when the bottles were packed inverted in the cartons. In no instance did "necks-down" packing make the pack more susceptible to breakage.[2]

On Testing the Hydrodynamic Resistance of Bottles

It might be well at this point to voice a brief word of warning in connection with the testing of the resistance of bottles to hydrodynamic breakage. During our studies we developed a single bottle tester which closely duplicated in-carton motion of the bottles. On this tester we attempted to evaluate various bottles for water hammer strength using water as the fluid contents. It was discovered that the repetitive action of the tester plus the different cavity distribution obtained with water produced an entirely different break from the mouse hole found in trade breakage.[3] Whereas the mouse hole fracture has an external origin, often at an abraded point on the outside surface, the test breaks were almost invariably of the hinge type with an internal origin at the junction of the base and lower sidewall. Baker noticed the same effect in his earlier study and we believe it to be the characteristic hydrodynamic water-produced fracture. Breakage with such an origin could hardly be expected to indicate the strength of a bottle with respect to the other type of fracture and for this reason any simulative tests using a water content seem of doubtful value.

Furthermore, even in tests using the normal product content there is a tendency for the hinge type break to predominate and such tests must be used and interpreted with great discretion, or erroneous and reversible results are likely to be obtained.

Since almost any bottle can be broken by the extremely severe internal impact produced by the more susceptible products, the occurrence of hydrodynamic breakage is no certain indication that bottles are weak or faulty. An exception may occur in the case of bottles which are badly damaged around the external lower sidewall. Experience has shown that the resistance of bottles to external impact

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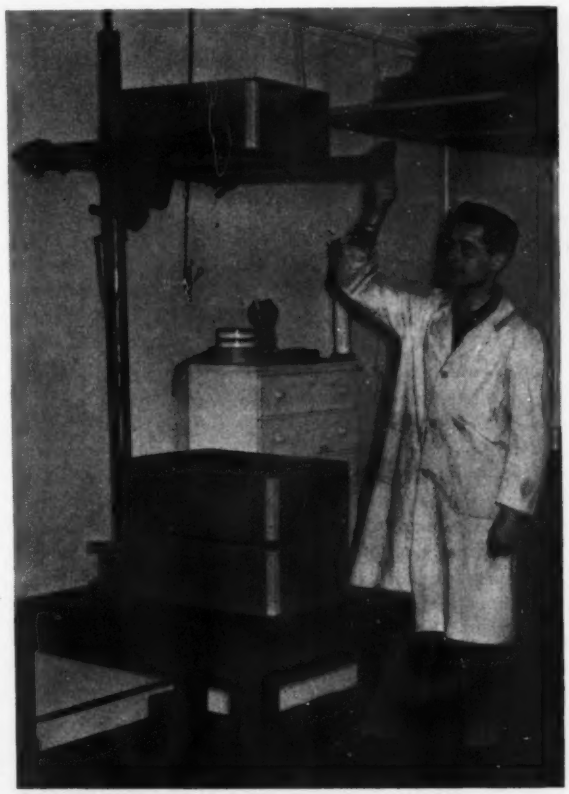


Fig. 4. Stacked carton drop test. When the upper carton was dropped hydrodynamic breakage occurred in the middle carton.

[2] The advisability of "necks-down" packing is, of course, somewhat dependent on the nature of the cap and contents and may sometimes be impractical from other than a hydrodynamic viewpoint.

[3] Baker, T. C., loc. cit., lists and illustrates nine characteristic fracture patterns, all caused by water hammer. The "mouse hole" and hinge type breaks, however, far outnumber the others, the former in the trade and the latter in tests, and seem to be the only ones worthy of mention from a practical viewpoint.

GLASS CONTAINER MANUFACTURERS MEET AT WHITE SULPHUR SPRINGS

Lewis F. Gayner, Executive Vice President of the Gayner Glass Works, was elected President of the Glass Container Manufacturers Institute at that organization's Annual Meeting held May 23-25 in the Greenbrier Hotel, White Sulphur Springs, W. Va. Mr. Gayner, who succeeds R. L. Warren, President of the Brockway Glass Company, had previously served GCMI as First Vice President, and has been a member of the board of trustees since 1945.

L. F. Gayner

J. C. Feagley

J. C. Feagley, Vice President and General Manager of the Glass Container Division of the Armstrong Cork Company, was chosen First Vice President, and was renamed a trustee. Harold F. Merritt, Vice President of Solvay Sales Corp., was elected Second Vice President.

Two new members were elected to the board of trustees: Royden A. Blunt, President of the Buck Glass Co., and Howard C. Herger, President of the Pierce Glass Co. They filled the vacancies left by G. F. Lang, President of the Carr-Lowrey Glass Co., who is a former President of the Institute, and by C. D. Rau, President of Fairmount Glass Works, Inc., both of whom completed their terms as trustees.

The proceedings were opened by Mr. Warren, who was followed by H. W. Prentis, Jr., President of the Armstrong Cork Co., and former President of the National Association of Manufacturers. Mr. Prentis' address entitled "So Much To Do—So Little Done" was both timely and inspiring.

The business sessions were devoted largely to discussion of promotions, including the one-way beer bottle, baby foods in glass and other possibilities for increasing and popularizing the use of glass containers. William E. Berchtold, of Foote, Cone & Belding, the Institute's advertising agency, reviewed the past six months' activities in the one-way beer bottle program, and slides were shown to illustrate test campaigns on baby foods in different parts of the country.

In a departure from previous practices, the reports of the standing committees were presented in mimeographed, summary form, rather than being read by the chairman, an innovation which not only expedited consideration of the essential features of each report, but also made room for expanded discussion from the floor. In each case, the discussion was conducted by the chairman of the reporting committee.

Market Research and Promotion

The Committee on Market Research and Promotion reported gains in the regional advertising and merchandising campaigns devoted to promotion of the one-way beer bottle. Cartoon-style ads, it announced, have been scheduled in selected newspapers serving areas in Michigan, Ohio, New Jersey, the Baltimore - Washington area, and upstate New York, in districts chosen because good beers are available and the brewers' support assured. This is being supplemented by advertising in 18 trade publications reaching brewers, food stores and package stores, and also through expanded use of the labor union press.

Additional point-of-sale display material, emphasizing holiday promotions, has been prepared by Foote, Cone and Belding, the Committee advised, and the Institute's public relations counsel, Theodor Swanson & Company, is sending out a monthly newspaper entitled "Glass Container News" to 23,000 key people in the brewing, wholesale distributing and retailing fields. Successful results were also reported from the brochure, "The Future of Glass Containers", which outlined the Institute's marketing program and solicited financial support.

In regard to baby food containers, the Committee told how glass-packed baby foods were featured in test promotions carried on with the cooperation of large food stores. Records kept by the participating stores revealed that gains registered by glass during the promotion were maintained after the sales of baby foods had returned to normal. This, the report pointed out, proves the value of sampling techniques then applied to glass-packed baby foods.

As a result of these tests, the Committee has prepared a broader program which will be presented to manufacturers of glass baby food containers for their approval.

The Committee, headed by I. J. Collins, Chairman of the Board of the Anchor Hocking Glass Corporation, also reported in a preliminary way on a study of the milk container market, an objective of which is to develop information on which a sound promotional campaign can be based.

H. A. Goodwin, General Sales Manager of the Fallstaff Brewing Corporation, took part in the report, as did Benjamin Wood, the Institute's Director of Marketing.

Labor Relations

The report of the Committee on Labor Relations, headed by L. C. Roche of the Maryland Glass Corporation, stressed as the most significant development, the increasing amount of unemployment in the glass container industry and the reduction in hours of work. It predicted that unions this year will seek such fringe increases as pensions, guaranteed employment and social

welfare plans. It also urged as large a representation of the industry as possible at the 1949 negotiations to be held in Chicago, commencing July 12. The Committee's report also summarized the minutes of its two meetings since the last report was rendered, and told how it has kept the industry fully informed on all important labor developments in the interim.

Traffic

A vigorous and unending battle against rising freight rates was reported by the Traffic Committee, headed by I. L. Dunnington of the Anchor Hocking Glass Corporation. Pointing out the absence of stability in the national freight rate structure, the report reviewed the tariff increases which became effective on January 11 of this year, and told how the Committee had used the industry economic approach before the ICC in protesting the rate increase.

The Committee also reported its role in the public hearing over the tariff interpretation dispute on applicable sand rates, and told how it is cooperating with the National Industrial Sand Association in regard to rates on sand used for making glass.

Considerable litigation before the ICC and the courts was predicted in regard to uniform classification ratings being prepared by the railroads, the initial proposals resulting in higher rates for the glass container industry. The Committee advised that every development in this important field is being closely followed.

Testing Procedures

The Committee on Testing Procedures, whose report was signed by its Vice-Chairman, J. H. Steuernagle of the Brockway Glass Company, was devoted largely to activities conducted at the Preston Laboratories under the direction of Dr. L. G. Ghering, including examinations in 26 injury claims involving 26 manufacturers of glass containers. The report reviewed various short term research laboratory projects, including the wall thickness study on 4/5-quart liquor bottles, the construction of a pendulum impact tester, and a study of the water hammer breakage phenomenon.

Results to date in the case of water hammer breakage have not been entirely satisfactory, the Committee reported, and recently both existing developed methods must be used with great discretion. It advised that further intensive work is necessary, and will have to involve elaborate and detailed study of the food products themselves.

The Committee is also proceeding with standards for amber color for beer bottles, and the Preston Laboratories now has on hand sample bottles from 31 furnaces. Hope was expressed that visual limit samples would be sufficient as a basis for control, rather than resorting to precise optical measurements of transmission.

Container Design and Specifications

The report of the Committee on Container Design and Specifications, headed by J. M. Foster, President of the Foster-Forbes Glass Company, listed and described new and revised container drawings, and reviewed its work in cooperation with its Technical Sub-committee in overcoming such problems as varying heights of baby food jars and the need for improved devices for removing pry-off caps. One of its more recent activities, it disclosed, has been in connection with the non-returnable bottle for carbonated beverages, and has under consideration drawings which will incorporate specifications for this line in 24, 28 and 32 oz. capacity sizes.

Reports were also rendered by the group's Sub-committee on Beer Bottles, headed by G. A. Mengle, Executive Vice President of the Brockway Glass Company, Inc., and the Sub-committee on Milk Bottles, led by R. M. Lamb, Jr., Treasurer of the Lamb Glass Company . A study of 11-oz. and 12-oz. beer bottles will be continued. The Sub-committee also reported brewer complaints regarding differences in height and shoulder contour of returnable beer bottles, notwithstanding detailed specifications promulgated in 1941.

The Sub-committee on Milk Bottles announced new drawings for 19 separate containers, plus revised copies for three others. It said that the Plan for Uniform Marking of Milk Bottles, in conformity with the regulations of the several states, is operating satisfactorily, although legislative action is necessary in a few weights and measures jurisdictions.

Government-Industry Relations

Two major activities not previously reported upon to the membership were included in the report of the Committee on Government-Industry Relations, headed by Mr. Gayner. One of these was the provision of industry data to a Sub-committee of the Senate Interstate and Foreign Commerce Committee, on request of Senator Homer E. Capehart dealing with the effect on the glass container industry of recent Supreme Court decisions pertaining to freight absorption.

The report also reviewed the work of a special subcommittee of technical people in regard to the long-term supply of various types of fuel for industrial purposes. It pointed up the waning supply of natural gas for melting during the winter months, the high cost of petroleum on a long-term basis as a stand-by-fuel, and the desirability of a compact, efficient gas producer sys-

An informal meeting of some members of the Board of Trustees of the G.C.M.I. Left to right: W. V. Fisher, President of Anchor Hocking Glass Corp.; F. E. Fuller, General Counsel for G.C.M.I.; R. A. Blunt, President of Buck Glass Co.; R. L. Warren, President of Brockway Glass Co.; L. F. Gayner, Vice President of Gayner Glass Works and new President of the G.C.M.I.; E. J. Costa, Vice President of Crown Cork & Seal Co.; H. F. Merritt, Vice President of Solvay Sales Corp.; I. R. Macdonald, Sales Manager of Dominion Glass Co.; and H. C. Herger, President of Pierce Glass Co. Absent Trustees at this unofficial gathering are J. C. Feagley, Vice President of Armstrong Cork Co.; F. W. McDonald, Vice President of Glass Containers, Inc.; and R. R. Underwood, President of Knox Glass Associates.

tem requiring less capital investment, less maintenance and utilizing lower grades of coal than existing methods. The Committee advised that Battelle Memorial Institute is studying a compact retort for the gasification of coal, and that Bituminous Coal Research, Inc., is interested in launching full-scale research in conjunction with other parties. The Committee has asked Battelle to make a written proposal to provide the basis for further consideration.

The report also mentioned the Committee's part in disseminating statistics on fruit and vegetable packs prepared by the National Canners Association and its work with the U. S. Department of Agriculture in connection with the government's School Lunch and Institutional Feeding programs.

Package Design and Specifications

A gratifying improvement in breakage experience, amounting to an approximate reduction of 50 per cent in transit damage as compared with the year before, was reported by the Committee on Package Design and Specifications, headed by P. A. Parker of the Anchor Hocking Glass Corporation. The most notable improvement established by the 1948 Freight Car Survey, which involved examining 195 cars of glass-packed products, was in the damage picture for gallons and half-gallons of commodities such as wines. The survey, according to the report, also uncovered some new sources of trouble, which the Committee hopes to remedy by better packaging.

The Committee also reported at length its successful cooperation with federal agencies, including the Army Packaging Board, the Navy Packaging Board, the Air Force Packaging Board, the Federal Specifications Board, the Quartermaster Food and Container Institute and the Armed Services Medical Procurement Agency. Intended to reduce government-agency resistance to glass containers, much of which traces back to improper wartime packaging and packaging specifications, the effort has resulted in better understanding on the part of the procurement agencies. At least three of the agencies have since submitted major specifications to the Committee for review and suggestions, and a number of revisions made by the Committee have been accepted.

Another aspect of the same general activity included the development of a new package for honey, to overcome the Agriculture Department's objections to glass-packed honey for the school lunch program.

The Committee advised that printing of the GCMI Color Chart for printing ink colors was under way, and that a glossary of the most commonly used terms of the box industry has been compiled. The glossary will be expanded to include discussions of the types of fiberboard and their advantages, as well as of the meaning of the tests used for fiberboard and boxes.

Glass Packed Products

The great need for expanded scientific research in the laboratories of the glass container manufacturers, especially in regard to problems encountered in packaging and processing in glass, was emphasized in the report of the Committee on Glass Packed Products, headed by John M. Sharf of the Armstrong Cork Company. It warned that unless regular, extensive and well-coordinated endeavor is sponsored generally in the industry, as compared with rather sporadic efforts in the past, the glass container will not enjoy an extensive, growing usage in the processed food industry.

The Committee announced that its future activities will cover the integration of commercial practice with the findings of the University of Massachusetts in a wide field related to glass packaged food products, plus the gathering and dissemination of technical information to the many processors of glass packed foodstuffs. It looked forward to stepped-up contacts with The Institute of Food Technologists, with a view toward formalizing a reliable exchange of useful information. It also reported that proposed pilot plant installations for exploring simplified sterile food packing in glass containers, at high temperatures, would be followed very closely.

The Committee also reported on its cooperative retort processing studies with the National Canners Association, and said that the joint activities conducted in their respective laboratories have been most fruitful. One significant result was the publication of Bulletin NCA-30-L, entitled "Processes for Low-Acid Canned Food in Glass Containers", heralded as an authoritative source of process times for every glass-pack processor, laboratory and regulatory group working with the food industry.

The various laboratory findings must be kept up to date, the Committee declared, mentioning specifically such continuing studies as the browning of food during processing and storage, the aging or flavor deterioration of food products, and the blending of fruit juices to improve quality and acceptability.

Standards for Finishes

The Committee on Standards for Finishes, headed by C. C. Green of the Armstrong Cork Company, underscored the need for close coordination between itself and the Committee on Container Design and Specifications, and reported on two joint sub-committee meetings since the last semi-annual accounting was made. Among the subjects discussed at these conferences were the 1710 finish with relation to an improved design for the baby food jar; interchangeability of Amerseal Finish with continuous Thread Finish, and the most satisfactory neck diameter for the catsup bottle with 30mm 1720 finish.

The report advised that study of the newly-proposed rounded "V" thread contour for the 400 series of finishes mentioned in its last report has not been concluded, inasmuch as tests for glass and cap fit are incomplete. It also stated that re-engineering of the Amerseal Finish is under consideration.

The convention concluded with a business meeting for the election of trustees and the reading of officers' reports on the morning of May 25. At this session, it was announced that the next Semi-Annual Meeting will be held in Miami, on November 14-16, 1949.

• Harold E. Strang has been appointed Manager of General Electric Company's Apparatus Department of the Meter and Instrument Division at Lynn, Mass. Mr. Strang succeeds Nicholas M. DuChemin, who recently was named an Assistant General Manager of the department.

HOW "ALL-GLASS" SEALED-BEAM AUTOMOBILE HEADLAMPS ARE MADE

BY LUKE L. STAGER
Tung-Sol Lamp Works, Inc., Boyertown Division, Boyertown, Pennsylvania

Some of the methods and equipment developed for the manufacture of automobile sealed-beam headlamps are unusual even in the lamp producing field. The combination of high production and precision, along with the requirements which must be met in heating and fusing the parts of the units into the final assembly, suggest that some of the processes employed may be applicable to other fields of manufacture where similar basic problems have been met and solved.

Although standardized for use on automotive vehicles by the Society of Automotive Engineers only since 1940, the almost universal adoption of the sealed-beam headlamp by vehicle manufacturers, the conversion to this type from now outmoded lamps on earlier vehicles, and the production required to meet replacement needs, have developed a demand for many millions of these units annually. Yet to date most of the information which has generally become available concerning lamps of this type relates to what may be termed "use factors", including current input, light output, beam candlepower pattern and limitations, lamp dimensions and sizes, and other data, rather than dealing with just how the lamps are made. Hence, a description of some of the manufacturing details which can now be disclosed seems of value.

The "all-glass" lamp is in effect a large "lamp bulb"

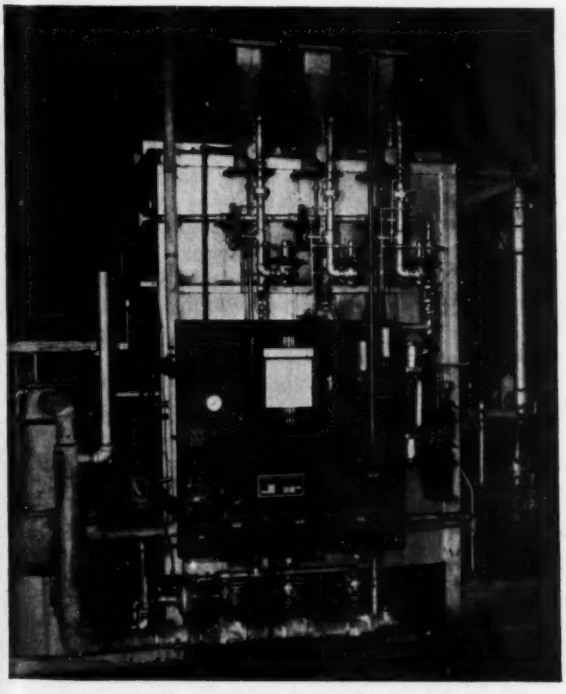


Fig. 1. High-hydrogen gas generator developed by Surface Combustion Corporation for Tung-Sol Lamp Works. Gas produced by this generator is used to heat and fuse various parts of sealed-beam headlamps for motor vehicles.

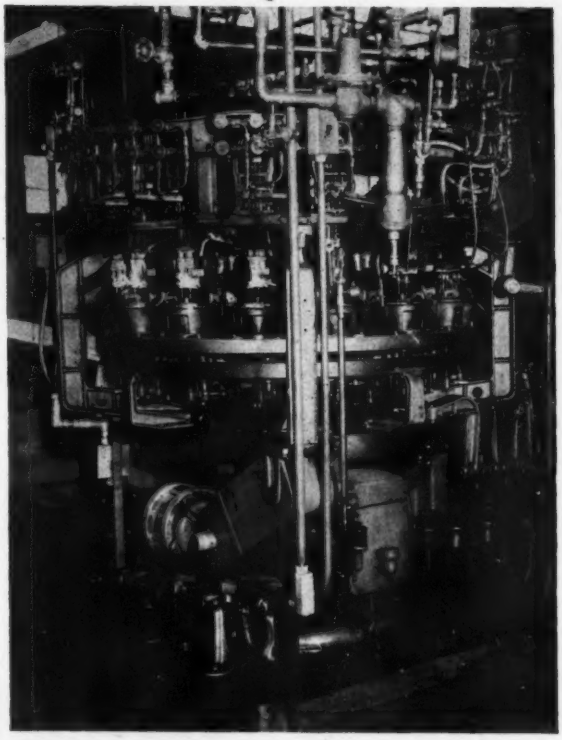


Fig. 2. Rotary table type automatic machine used to fuse wires for lamp filaments into reflectors of sealed beam headlamps. Small torches rotate around reflector openings to heat and fuse three connections to filaments. Clean, short flames are required for fusing gas-tight joints.

with all light-producing elements permanently installed therein. The internally coated reflector and lens are so intimately joined or fused together that they form a vacuum-tight single piece, completely impervious to the infiltration of air or moisture, so that deterioration of the reflector is impossible for the life of the lamp. The light output, therefore, remains virtually the same during this period.

To produce each lamp, not only must the two major parts—lens and reflector—be fused together, but in addition, numerous small pieces must first be assembled prior to sealing into the reflector. In the completed lamp these consist of two filaments (high and low beam), three mounting pegs, three terminals and an evacuating tube. The reflector must also be coated with metallic aluminum. In assembling these parts, extreme precision is required so that the light beam pattern and current consumption of the two beams will be within the specified limits as now established by the S.A.E. and the Illuminating Engineering Society.

Most of the machinery performing the various assembly operations must be automatic in view of the large

production required. While some manual operations are confined to loading and unloading the machines, others demand a high degree of skill. This applies especially to the sub-assembly of the filaments, pegs and terminals, so that they will be correctly located within the lamp when completed.

Production at this point begins with the molded glass lens and reflector. At the Boyertown plant the filaments are wound from wire stock, pegs and connectors are combined, and all subsequent operations in the manufacture of the lamps are performed. Two major fusion operations are performed automatically, which originally involved several problems. The methods employed should be of interest not only to those who are manufacturing products in which glass is a constituent, but also in operations where the flame and combustion characteristics found necessary to fuse the glass may be applicable to some other rapid heating operations.

The characteristics of the heating flame used for glass fusion are highly important. The flame must provide a fast, clean heat, free from any possible deposition of carbon or other gas constituent. It must also be hot and short, as the heat must be applied to very localized areas, and must bring the glass to fusion temperature at the joint before surrounding areas become overheated. The glass must melt where fusion is to occur, but must remain firm a fraction of an inch from the fusion point or surface. Thus a high rate of flame propagation, equivalent to a rapid rate of combustion, is required.

While the oxy-acetylene flame and the natural gas (methane)-oxygen flame are eminently satisfactory for many applications in industry and even for localized heating of glass, as for rounding the edges of glass tumblers, etc., neither has proved suitable for the intimate and complete fusion necessary to make a vacuum-tight joint in sealed-beam lamps. Although short and hot, the flame lacks the required cleanliness with either of these combustion gases. The oxy-hydrogen flame, or in this case a variant of it, has, however, proved quite satisfactory.

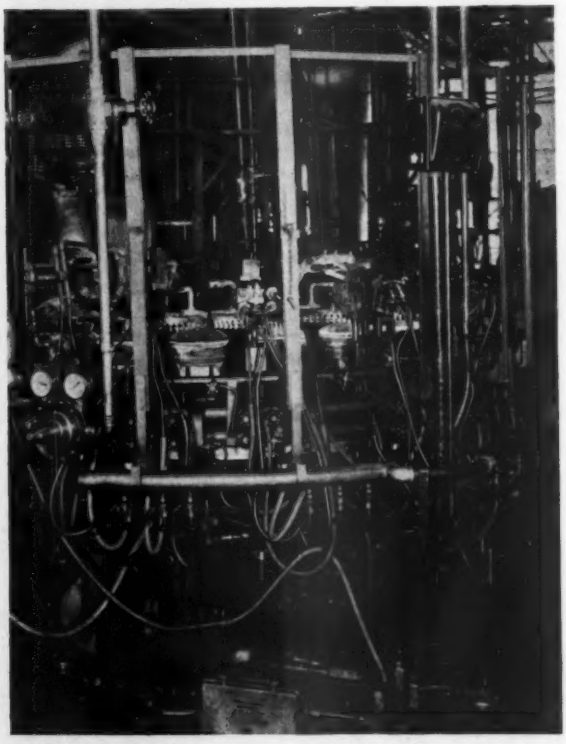


Fig. 3. Rotary table type automatic machine used for fusing sealed-beam lamp lenses to reflectors. Lamp assemblies rotate under rings of small torches to obtain rapid clean heating with high-hydrogen-oxygen flames.

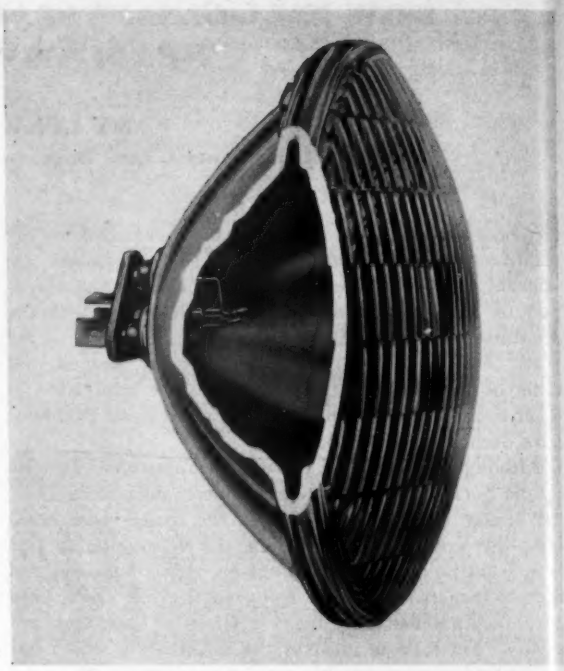


Fig. 4. Cutaway view showing both interior and exterior of Tung-Sol all-glass sealed beam headlamp for motor vehicles and similar lamp applications.

The combustion gas now used throughout the plant for all heating operations is a specially prepared high-hydrogen gas, burned with oxygen supplied from commercially available "bottles". The use of this gas was decided upon after tests showed that it met necessary requirements, and would be less costly than bottled hydrogen. The gas is produced by an atmosphere generator developed by the Surface Combustion Corporation, Toledo, Ohio, especially for the purpose, although the basic design of the generator is similar to that used for the RX generators made by this company for metal heat-treating operations. The analysis of the gas is approximately as follows:

Hydrogen (H_2)	64.5 per cent
Carbon Monoxide (CO)	27.0 per cent
Methane (CH_4)	0.5 per cent
Carbon Dioxide (CO_2)	1.0 per cent
Nitrogen (N_2)	7.0 per cent

(Slight variations from the above analysis occur depending upon generator gas output, but invariably the total hydrogen-carbon monoxide content is in excess of 90 per cent, with the hydrogen exceeding 64 per cent.)

The generator produces the gas from propane, although it can be operated on half propane and half butane. The rated capacity of the generator is 1500 cubic feet per hour, although it has been occasionally operated

(*Continued on page* 414)

STRUCTURAL CHANGES IN THE GERMAN GLASS INDUSTRY

The German glass industry is one of the 30 industrial groups forming part of the general German economy. The last pre-war statistics showed the following figures:

Group I	210 glass-works (manufacturing only) establishments
Group II	492 establishments of the pressed and blown glass processing (mirrors, etc.) and glass manufacturing industry
Group III	378 establishments of the flat glass industry.

They employed 73,604 wage earners totaling 112.6 million RM wages per year, classified as follows:

	Wage earners	Wages in year in millions RM (1 RM=$.25)
Group I	59 331	94.6 mill. RM
Group II	8 240	9.4 mill. RM
Group III	6 033	8.6 mill. RM

These figures pertaining to employment and wages show that the glass-works industry is predominant among the three groups. The German production statistics figure the gross production value, and a net value after deductions that have to be made for raw and other materials, semi-manufactures, fuel, packing material, etc., which come under the heading of another industrial group. These figures (in million RM) are as follows:

	Gross Value of Product	Deductions	Net Value of Product
Group I	268.4	78.4	190.0
Group II	41.6	13.4	28.2
Group III	34.8	15.4	19.4

The net value amounts to .7 per cent of the German industrial total. The statistics also contain the export percentage of the total production in the 3 groups:

	(1 RM=$.25) Mill. RM	% of turnover
Group I	46.9	17.5
Group II	13.8	33.4
Group III	1.7	4.9

The export figures of the various manufactures of these groups are classified as follows (in millions RM): sundry household glassware, plates, dishes, bowls, etc., white: 9.1; colored: 1.5; ground, etc: 5.5; upright, ink, perfume and other bottles, natural color: 3.0; white: 4.9; colored: 0.4; lighting glass white: 3.4; colored: 1.8; ground: 0.9; painted, gilt or plated: 0.7; sheet glass, blown or machine-made: 3.9; mirror and sheet glass, colored or opaque: 1.0; ornamented glass: 0.9; cast mirror glass 4.3; photo plates: 2.7; wire glass: 0.8; spun glass, wool glass; etc.: 2.3. Some of these manufactures were exported to the United States but not to any extent above the average European export. As is known, the trade relations between Germany and the U. S. A. were retrogressive during the period intervening between the two World Wars, particularly after 1933.

Post-war dismantling involving the removal of factory installations went much farther in the Russian Zone than in Western Germany. Production statistics are not published in the Russian Zone except occasional target percentages which do not throw much light on the subject. In the British and United States Zones, regular industrial reports are issued again, permitting gauging the effects of the monetary reform. (The monetary reform took the old paper money out of circulation issuing new bank notes at 90 per cent discount which quota was later on somewhat modified.)

The monetary reform did not materially affect flat glass production. The fear that the building industries would cancel orders proved unfounded. In many cases the customers sent trucks to the works to get the glass. Flat glass was soon in such demand that the delivery terms had to be extended to 2 months; in the case of cast glass to 3 months; and in the case of safety glass even to 10 months. Pressed and blown glass was in full supply. Glass containers for preserves were in specially heavy demand so that prices were bound to rise. There remained a shortage of glass workers in the pressed and blown group. Additional difficulties arose in the supply of raw and basic materials such as soda ash, coal and various chemicals.

In the further course of production, other tendencies were noticeable. For a time, special categories such as photo plates were less in demand while the demand for thick glass, for shop window panes and wire glass increased. Bottles were less in demand owing to the shrinking beer consumption. In general the monetary reform did less harm than the rise in taxation which made it hard to lay up surplus reserves and working capital.

The glass industry had its share too in the general rise in exports showing an upward trend for 1947 and 1948. In the last prewar years, Germany furnished 28 per cent of the total glass export of the world. That figure has not yet been reached. One of the chief customers is the Netherlands who, among other things, bought 240,000 square meters (2½ million square feet) of wire glass. Window panes too find a ready market in the Dutch places near the border. Other customers for special technical and optical glassware, including spectacles, eye-protecting spectacles and watches, were Switzerland, Sweden and the United States. Mirror glass, originally meant for the Near East, was exported to Denmark where some firms had taken over part of the Near Eastern trade. The increase in pressed and blown glass exports went to Belgium and the Netherlands, including tubes used for the manufacture of glass instruments. In addition, household glass of various kinds was exported. The export trade in refined blown and cut glass, such as stemware, is partly handled by the new associations

and establishments run by the expert workmen from Sudetenland. The glass fibre industry has not yet reached its full export capacity. The Hanover Fair gradually developing into the most important fair of Western Germany has achieved good results in stepping up exports while the Leipzic Fairs are increasingly exhibiting the products of the Russian Zone, mainly of the expropriated establishments, the so-called "volkseigene Betriebe" (owned by the people).

The influx of German workmen from Czechoslovakia brought about great changes in the productive capacity of the German glass industry.

The glass industry of Czechoslovakia led in the manufacture of consumer goods in mass production of jewelry and de luxe articles, Northern Bohemia with its predominantly German population being the glass district par excellence. Most Bohemian glass works were situated round Teplitz-Aussig. Here, manufacturing profited by cheap fuel coming from nearby coal fields, as well as by the short routes for transporting the needed chemicals from the chemical plants in the near vicinity. The river Elbe with its lively navigation favored the transport of raw materials, as well as of the finished products that for the most part went abroad via the mouth of the Elbe (Hamburg, etc.). This applied to the establishments manufacturing bottles, sheet glass, pressed and blown and flat glass. In conjunction with the manufacture of jewelry, the Gablonz glass industry exported widely to Africa, India, South America and Australia as main customers. In addition, lead crystal goods (table, toilet and decorative ware) were manufactured and exported besides blown glass, lamps, etc. For the development of their domestic and foreign trade, these industries could draw on a permanent staff of highly qualified workmen. The same holds good of the glass industry of the Böhmerwald, Moravia and Slovakia. Excellent trade schools helped to carry on the traditions of the older generations and to develop the artistic tastes of the younger generations. The annual export of glass and glassware exceeded a billion Czech crowns ($30,000,000), United States, Great Britain, France, Italy and other countries being the principal customers. These goods ranked fifth in the export list.

When Germany collapsed, the Sudeten Germans, i.e. the Czechoslovak citizens of German descent, were evicted from their homes and factories and had to find refuge in the overpopulated areas of Western Germany. In this way, the larger part of the Czechoslovakian glass industry lost its skilled workmen. The majority of the Gablonz workmen went to Bavaria and settled there in various districts. At Kaufbeuren jewelry and wooden ware are now manufactured.

A number of associations for the purchase of raw materials have been started. Owing to the loss of factory installations that had to be left in Czechoslovakia and part of the working capital, production is still fairly low. In this connection, it deserves mention that Czechoslovakia has thought of bringing a selected group of skilled workmen back to Gablonz, and Austria too is active along the same line. Another section of the North Bohemian glass industry from Haida and Steinschönau has been domiciled in the Rhenish districts of Bonn, Euskirchen and Düren. For a start, eighteen glass refining works have been settled there which are likely to be enlarged in future. Conditions are more favorable here than in Czechoslovakia, the raw materials required for the glass industry being within easy reach and transport conditions in Western Germany and Western Europe being ideal. Two glass works are under construction at Euskirchen which are to be managed by experienced master smelters from North Bohemia using old formulae. A state training school for skilled workmen is to be opened for courses in glass refining and ceramics. In the beginning production will be confined to the home market with export to follow later. It is evident that in this way the German glass industry is undergoing structural changes, the scope and effects of which are not yet to be foreseen. Last year one of these groups in Bavaria turned out goods valued at about 21 mill. RM, the majority of the glassware and jewelry supplying the home market with only a small fraction being exported. A number of export orders could not yet be carried out owing to the lack of certain highgrade raw materials.

These developments in the Western German glass industry contrast with the stagnation in certain glass manufacturing branches in the Russian Zone where part of the supplying plants have been dismantled and others are barred from delivering across the zonal frontiers. This applies to the manufacture of laboratory appliances, distillation apparatus, thermometers, electrotechnical rectifiers, illuminating tubes, insulating flasks (thermos flasks), alcoholo- and oleometers and other apparatus. This branch of the glass instrument industry uses glass tubes of various dimensions and quality. Only part of these were manufactured within the area, the rest having to be supplied from the Schott Glass Works in Jena (dismantled) and from the glass works in the Ruhr district (behind the zonal barrier).

It must not be overlooked that the zonal frontier splitting Germany in two is acting as a real frontier so that the import of glass tubes entails licenses and endless red tape, and only a limited number of tubes can be procured this way. The Thuringian glass tube manufacturers had to close down for some time owing to lack of coal so that supplies to the instrument industry stopped just when it might have had a larger share in the export business. Thus, this particular branch of the glass industry is depending on the opening of the zonal barriers and on the re-establishment of such plants as the Schott Glass Works at Jena which furnish the necessary supplies to the glass instrument industry.

STUDENT BRANCH OF A.C.S. HOLDS MEETING

A meeting, reported as highly successful, was recently held by the Virginia Polytechnic Institute Student Branch of the American Ceramic Society at which W. Ronald Lester of Dominion Minerals, Inc., presented a lecture on "Raw Materials and Batch Handling Techniques and Equipment in the Glass Industries". Mr. Lester's talk was illustrated with a series of slides and many questions were answered by the speaker in the discussion which followed.

Also present at the meeting were John W. Whittemore, immediate past-President of the Society, and Victor V. Kelsey, President of Dominion Minerals, Inc. and past President of the American Ceramic Society.

HEAT AND RADIATION IN GLASS AND CERAMIC TRADES

By KARL DUNN, Industrial Hygienist

Corning Glass Works, Corning, N. Y.

Karl Dunn, industrial hygienist, discussed the problem of heat radiation and the ways in which workers react to it. Mr. Dunn showed the effects of various temperatures on workers and told what can be done and what is being done to solve the problem and improve working conditions.

Of all the heat lost through a furnace, radiant heat is by far the most important. The source is the infrared rays, non-visible to the eye and non-heat producers in themselves, generating heat only when they strike an object.

To illustrate the rapid increase of radiant heat as the temperature of the furnace is increased, Mr. Dunn showed that when a furnace operating at 1000 degrees is raised to 1100 degrees, the temperature increased 10 per cent and radiation jumps 47 per cent. A furnace operating at 2000 degrees brings the temperature up 100 per cent and the radiation to 1500 per cent.

Such an increase in radiation upsets the human heat balance and a man working close to the furnace is taking on more heat through radiation than he can lose through convection and evaporation.

There is no adequate way to measure temperature, radiation and air movement. Thermometers now in existence merely measure the expansion of mercury, and Mr. Dunn illustrated this point by citing the case of three metal containers: one covered with foil, one painted black and one ordinary metal can and all subjected to the rays of a heat lamp. Thermometers placed in the three cans register three different temperatures, proving that thermometers react only to surroundings, and nothing else. Mr. Dunn pointed out that man's reaction is similar to that of the black container. Infrared rays pass through the can, as through a man's body, and force the temperature up. The one wrapped in tin foil, of course, had the lowest temperature, since the foil screens out the heat producing rays. Man picks up radiated heat irrespective of color of skin.

To show the effects of radiant heat on the worker, Mr. Dunn told of putting a replica of the Corning Glass Works trademark (glass blower) through a series of heat tests, while his temperature changes were recorded on a clinical thermometer.

The little man, with a temperature recording device strapped around his waist, was subjected to radiation from a tiny glass furnace. Almost immediately the infrared rays increased the man's temperature to 105 degrees. A heat absorbing glass, which would remove the infrared rays, was inserted between the man and the furnace, and the man's temperature returned to normal.

Next an infrared transmitting black glass was placed between the man and the radiant source, but the black glass did not screen out the infrared rays and the man's temperature began to rise again.

As a further experiment, fans were connected and placed directly on the man, but served only to increase his discomfort as his temperature continued to rise because of the heating of the fan's blast by the furnace heat.

To demonstrate the pressure of rays of light, Mr. Dunn noted that when he placed a radiometer in the rays of a heat lamp, the vanes were shortly spinning rapidly. The vanes were black on one side (heat absorbing) and plain on the other (heat reflecting), suggesting that some type of reflective clothing might be developed to offset heat radiation's effect on the worker.

What can be done, then, to shield the man from the radiant source and not impair his efficiency?

Heat suits have been used in emergencies, but they are cumbersome and for a worker who has to be other than stationary at his job they are not practical.

A screen of aluminum foil between the worker and the radiant source will filter out the infrared rays and maintain the worker's temperature near normal. However, with such a screen between him and his job, the man is unable to visually follow his work.

Mr. Dunn demonstrated also the effectiveness of a blackened copper screen when placed between the man and the furnace. The man's temperature in this instance remained near normal, and in addition he had the advantage of being able to see his job.

With the use of such screens as aluminum foil and black copper mesh, a hood would be constructed at the top of the furnace, with blowers to shunt the heat up toward the roof.

Right at the moment experimentation is going forward on various types of fabrics, in an effort to discover one that may have the necessary qualities to offset or screen out heat radiation.

An address given before the Glass Division of the National Safety Council.

O-I SHIFTS MANUFACTURING FACILITIES

J. P. Levis, President of Owens-Illinois Glass Company, has announced that American Structural Products Company, a subsidiary, will acquire all of the industrial and electronics manufacturing facilities formerly centered in the Kimble Glass Division of the firm. The American Structural Products Company will also continue to manufacture and sell Insulux glass block.

Stanley J. McGiveran, Vice President of Owens-Illinois and General Manager of its Kimble Glass Division, will also become President and General Manager of the American Structural Products Company, Mr. Levis further stated.

At the same time, the company will acquire from American Structural Products, the latter's facilities for manufacturing Kaylo insulating materials. The Kaylo business will be operated as the Kaylo Division of Owens-Illinois Glass Company with T. A. Collins as General Manager.

GLASS TECHNOLOGY EXPANDED AT UNIVERSITY OF TOLEDO

It has just been announced by John B. Brandeberry, Dean of the College of Engineering, University of Toledo, that the Glass Technology courses have been organized into a graduate program which will lead to the degree of Master of Science in Glass Technology. Applicants are now being enrolled to start the courses in September, 1949.

When the present junior class of those who enrolled in Glass Technology courses two years ago graduates, the whole emphasis in this field will be in the graduate program. Students who have graduated from a recognized college or university with a major in chemical engineering, chemistry or physics, are eligible for the graduate course.

Two preparatory courses—one in Mineralogy and Crystallography, and another in Glassmaking Materials —will be offered for students who have no adequate preparation in these fields.

Courses in the field of Glass Technology include Fuels and Combustion, Pyrometry, Microscope and X-Ray Techniques, Unit Operations of the Glass Plant, Glass Technology, Glass Manufacture, and Advanced Glass Studies and Seminar. Among electives are classes in Optics, Heat and Thermodynamics, Engineering Electronics, Machine Design and Industrial Engineering. The committee on entrance to the Glass Technology course will take into consideration certain practical work done in some of the fields of study, it was stated.

The program in glass technology is administered by the University's College of Engineering. It is worthy of note, however, that the program was initiated and the curricula determined in consultation with representatives of Toledo's glass industry. Serving on the Advisory Committee are Clarence L. Babcock, chief of the glass technology section, General Research Division, Owens-Illinois Glass Company; Alfred E. Badger, research supervisor, glass technology department, Libbey-Owens-Ford Glass Company; Alan L. Simison, manager of the technical control department, Owens-Corning Fiberglas Corporation; John B. Brandeberry, Dean of the College of Engineering, University of Toledo, Chairman; Walter V. Burg, head of the Department of Chemical Engineering, University of Toledo; Raymond L. Carter, Dean of Administration, University of Toledo. The presence on the advisory committee of representatives of three major glass manufacturing companies is symbolic of the glass technology program's unique and most significant advantage—close cooperation between industry and education.

As an example of the participation of industry in the conduct of the program, Glass Manufacture II, an advanced course, is devoted to study of glass as used in the container, the glass fiber and the flat glass fields. Subjects will be taught by representatives of Owens-Illinois Glass Company, Owens-Corning Fiberglas Corporation and Libbey-Owens-Ford Glass Company, respectively. The seminar on Advanced Glass Studies, also offered in the senior year, will be conducted in small groups under the direction of specialists from the Toledo glass industry.

A new glass technology laboratory has been equipped by the University in cooperation with Toledo glass industry. It is designed for the examination of physical and chemical properties of commercial glasses. It was opened for use last February.

Electron micrographs of film deposited on glass are studied by R. Arthur Gaiser, left, and Charles M. Browne, of the research staff of Libbey-Owens-Ford Glass Co. By means of transparent metallic film, glass is now made to conduct electricity. The electron-microscope is used jointly by the University of Toledo and the glass company.

The glass technology program is designed further to utilize its important advantage arising from its location in Toledo. Campus classroom and laboratory work is supplemented and made more significant by instruction during tours of the laboratories and plants of Toledo glass manufacturers.

The cooperation between school and industry is by no means one-sided. University facilities, the electron microscope and the spectrograph, for example, are being used by glass company technicians. Several glass technology students are employed on a part-time basis in the research laboratories of Toledo glass companies.

Other parts of the favorable "environment" for the University's program are the Toledo Public Library and the Toledo Museum of Art. The Library's department on glass and related industries is recognized as one of the nation's most complete. It includes American and foreign periodicals on the subject. The most recent bibliography in glass and related industries, compiled by the library's Technical Department, lists some 30 pages of publications exclusive of state bulletins and those of the U. S. Bureau of Standards. All of these are available for use by the University's glass technology staff and students.

(*Continued on page* 415)

INVESTIGATION OF THE GLASS STRUCTURE USING RADIOACTIVE TRACERS

By HENRY H. BLAU and JAMES R. JOHNSON

Department of Ceramic Engineering, The Ohio State University, Columbus, Ohio

The use of radioactive tracers affords a means of obtaining new fundamental knowledge of glasses and the vitreous state. Although fairly satisfactory conceptions of the glass structure are available, there still remains a distinct dearth of information as to the mechanism by which these structures come into being or as to why glass structures actually form or persist. This knowledge is not merely desired by the glass technologist to satisfy his scientific curiosity; it is essential as a basis for predicting whether or not a composition or system will form a glass. Although this type of precise knowledge has long been sought, its acquisition has had to await the development of more refined techniques. The present research using radioactive isotopes as tracers for this purpose has already progressed far enough to demonstrate that there are now adequate techniques available. The quantitative data thus being acquired can be used to supplement the previous concepts of the fine structure of glass so as to extend further our knowledge of glasses and the vitreous state of matter.

Structure of Glass

The present-day views on the structure of glasses are the outcome of scientific work in many fields, but they are for the most part an extension of modern theories in one field: crystalline structure or architecture. Crystals are represented as being built up of regularly arranged and repeated lattices of ions or atoms. Using this as a basis, Zachariasen[1] advanced the hypothesis that glasses consist of a random network of ions or ion groups in contrast to the regularity of the crystal lattice. In silicate glasses the basic unit of the irregular network is believed to consist of a group comprising one silicon ion surrounded tetrahedrally by four oxygen ions. In crystalline forms of pure silica, these tetrahedra are arranged in a regular lattice and are held together by oxygen ions at apexes of the tetrahedra; the apexes are shared by the silicon ions of adjacent tetrahedra. Figure 1 illustrates such an arrangement for crystalline silica. Figure 2 shows the arrangement of the tetrahedra in silica glass. Here the basic tetrahedral units remain, but the regularity of angles between them is gone so that a random network rather than a regular lattice results. The structure of a soda lime silicate glass is similar to that of the silica except for modifications by the two additional cations, sodium and calcium. The sodium and calcium positions and their contribution to the structure are shown in Fig. 3. These modifying cations enter the structure at high temperatures by supplying an oxygen ion to a shared corner of two adjacent tetrahedra, thus forming two corners which are then bonded by the cation or cations supplying the oxygen. This latter bond may be thought of as an ion "bridge" and is considerably weaker than the bond formed by the original corner-shared tetrahedra.

B. E. Warren[2] and his co-workers have confined these views through exhaustive and highly refined x-ray diffraction studies and established the exact spacing of the ions in the basic silicon-oxygen tetrahedra as well as the statistical distribution of the other ions in the structure. This work definitely established the irregularity of the bond angles in the structures other than those of the fundamental tetrahedral units. It led to the distinction that the silicon and other similarly small and highly charged cations function as network formers and that the larger lower-charged cations such as sodium and calcium serve as modifiers of the network.

Reprinted from *Engineering Experiment Station News*, The Ohio State University, December 1948.

1. W. H. Zachariasen, "Atomic Arrangement in Glass," *J. Am. Chem. Soc.*, *54*, No. 10, 3941-51 (1932).
2. B. E. Warren, "Summary of Work on Atomic Arrangement in Glass," *J. Am. Ceram. Soc.*, *24*, 256 (1941).

Fig. 1. Schematic arrangement of SiO_4 tetrahedra in a crystalline form of silica; radii as illustrated not proportional to actual ionic radii.

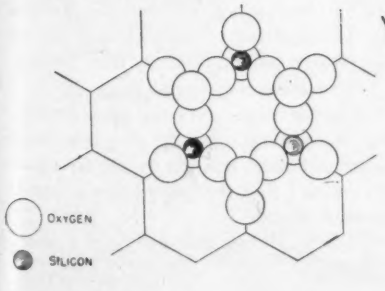


Fig. 2. Schematic arrangement of SiO_4 tetrahedra in silica glass; radii not proportional to actual ionic radii.

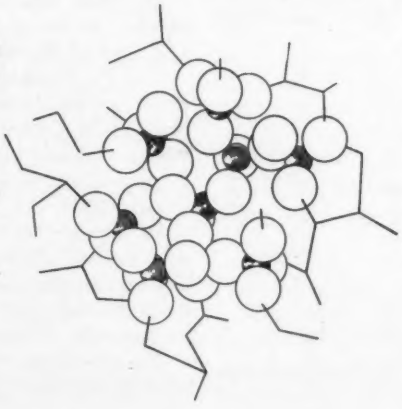
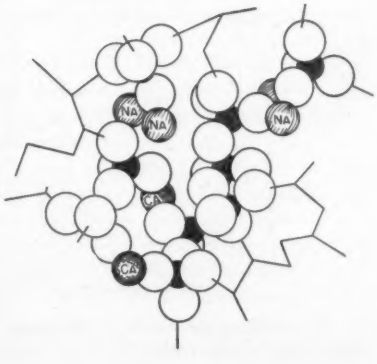


Fig. 3. Schematic arrangement of SiO_4 tetrahedra and Na and Ca cations in a soda-lime glass; radii not proportional to actual ionic radii.



Energy of Activation Values

The reason some silicate systems readily resolve themselves into the regular crystalline arrangements so that they cannot form glasses even when cooled by quenching, and other similar ones persist in the irregular arrangements of the liquid state even when cooled slowly, cannot be predicted from the thermodynamic properties such as the free energies in their fused or their crystal states. This anomaly leads logically to the assumption that certain "potential energy barriers" must be surmounted before the systems can be crystallized. Thus a certain energy of activation must be imparted, exceeding the magnitude of the barrier, before the compositions can be crystallized. (Figure 4 illustrates this schematically.) In the cases of the systems which form glasses, it is suggested that the magnitudes of the energies of activation must be relatively great is comparison with those of other systems. Their precise evaluation is made possible by application of methods utilizing as tracers radioactive isotopes of the characteristic ions of silicate glasses.

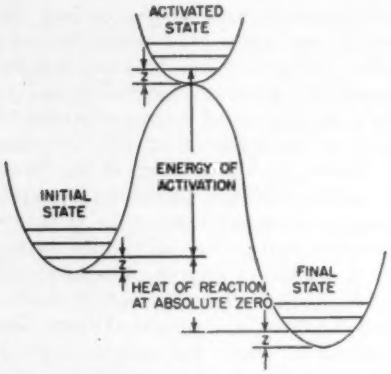


Fig. 4. Schematic representation of relation of energies of activation to initial- and final-state energies.

The rate of diffusion of an ion in glass at any particular temperature is dependent on the energy required to move the ion from one equilibrium position in the structure to the next. This energy in turn is dependent on the ion bond energies, ion sizes, interionic distances and interstices in the structure. Preliminary work in developing a technique for using radioactive tracers with glass indicated that the method was applicable to the problem. Up to the present time, however, equipment shortcomings and human errors have limited the reproducibility of results. Using a newly developed photographic technique, a temperature control which is accurate to $\pm\frac{1}{2}$°C, and minor refinements in handling methods, we found that values of the diffusion "constant" D at temperatures in the range 550—750°C are reproducible to within less than 3 per cent. The value of D at any temperature is found by measuring the slope of a plot of the log relative concentration of radioactive ions, which have diffused through the glass from an interface, against the square of the distance through which they have diffused. Figure 5 is such a plot for Na^{24} diffusing through a glass at 650°C. The value D is then calculated from the equation.

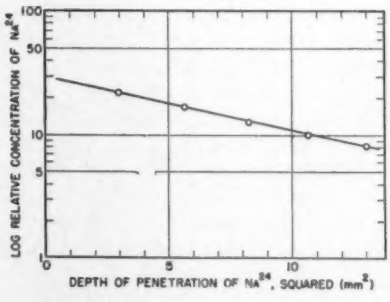


Fig. 5. Penetration curve for diffusion of Na^{24} tracer into a soda-lime glass at 650°C.

$$D = \frac{.1086}{\text{slope} \times \text{time.}}$$

The time used in the equation is the time in which the ions were diffusing at the particular temperature described. By calculating values of D for several temperatures, it is possible to obtain a curve of log D against $1/T$, where T is the absolute temperature. The slope of this curve is a measure of the energy of activation required to move the ion from one equilibrium position to the next according to the equation,

$$D = Ae^{-E/RT}$$

where D is the diffusion "constant," A is a constant, E is the energy of activation, and T is the absolute temperature.

The work to date has progressed far enough to demonstrate that true fundamental values of energy of activation are being made available. It is believed that these will afford an explanation of the reasons underlying the characteristic random structures of glasses and that they will also throw considerable light on such properties as the viscosities and strengths of glasses. These latter findings should have practical significance in improving the performance of glass products and the processes by which they are formed.

ASSOCIATION FORMED BY PATENT LAWYERS

The formation of the Toledo Patent Law Association to develop patent, trademark and copyright laws and their administration and explore problems of the profession, has been announced. Fifty Toledo patent attorneys and the engineers with whom they work are charter members.

The first president of the new association is Carl Staelin, secretary of Owens-Corning Fiberglas Corp. and head of the firm's legal and patent department.

Carl F. Schaffer, of the patent law firm of Owen & Owen, is Vice President; Henry K. Leonard, of Marshall, Marshall & Leonard, is Secretary; William E. Nobbe, patent counsel for Libbey-Owens-Ford Glass Co., is Treasurer, and J. R. Hoge, patent attorney for Owens-Illinois Glass Co., is executive member-at-large.

An objective of the association, says the constitution, will be "to protect the administration of such laws against practice and practitioners tending to impose upon the public or otherwise to bring the patent, trade mark or copyright systems into dispute."

The association will hold 10 monthly meetings a year, missing July and August.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Method of Making Parisons. Fig. 1. Patent No. 2,471,-369. This patent was assigned to Carr-Lowrey Glass Company by Charles B. Garwood. The general idea of the patent seems to be to reduce the time of contact between the parison and the parison mold which causes excessive chilling and results in defects when the parison is blown in the blow mold.

In accordance with the invention, the gob is delivered to the parison mold, a settle blow is applied to pack the glass into the neck ring and around the neck pin and then a blow back expands the parison against the walls of the mold and against the baffle, all in accordance with the usual practice. Then a slight suction is applied to the parison which contracts it slightly so as to remove it from contact with the walls of the mold. This prevents excessive chilling of the glass and results in a better bottle when blown in the blow mold.

Fig. 1 shows a blank or parison mold 1, a blow head 2, a baffle 3, and a neck ring 4, all of which may be of the usual construction and operated in the usual manner. There is also an air chamber 6 connected with a valve 8 which may be turned to connect the air chamber with compressed air from a pipe 9 or with vacuum from a pipe 10. As shown in the figure, the valve has been turned so that a slight vacuum is applied to the bubble in the parison and this acts to collapse the parison enough to bring its outside surface out of contact with the walls of the mold. The parison is then transferred and finish blown as usual.

The following references are of record in the file of this patent: United States Patents: 744,007, Proeger, Nov. 10, 1903; 851,163, Cox, Apr. 23, 1907; 1,635,704, Canfield, July 12, 1927; 1,680,544, Ingle, Aug. 14, 1928; 1,680,746, Peiler, Aug. 14, 1928; 1,945,982, Rowe, Feb. 6, 1934; and 2,063,463, Rowe, Dec. 8, 1936.

Corning Molding Machine. Fig. 2. Patent No. 2,472,-660. This invention by Harrison P. Hood was assigned to Corning Glass works. The particular object of the invention is the high speed production of small glass jewels for the bearings of delicate instruments.

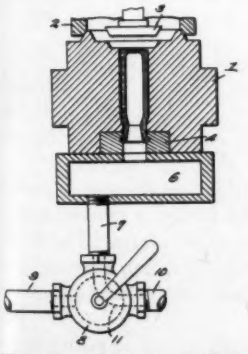


Fig. 1. Method of Making Parisons.

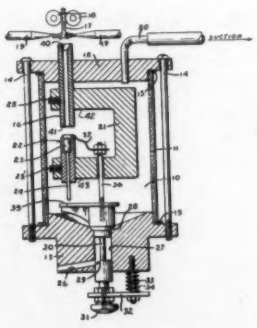


Fig. 2. Corning Molding Machine.

The apparatus is enclosed in a glass tube 11 having air tight end closures 12 and 13. The upper closure 12 has a gob delivery tube 16, the upper end of which is in position to receive gobs from the end of a glass rod 17 fed by rollers 18 through the flame from burners 19. This closure has connections 20 to a source of vacuum so that subatmospheric pressure can be established in the chamber.

A mold support 21 is adjustably secured to the tube 16 and the lower leg of the support carries a vertically adjustable mold 22 having a bottom 23 which can be raised by a pin 24.

The bottom closure 13 has an air lock comprising the vent 26, a chamber 27, a poppet valve 28 and a piston valve 29. The whole construction is such that the lowered atmospheric pressure in the chamber will cause a gob of molten glass to pass downwardly through the tube 16 at high speed and forcibly injected into the mold 22 where it is immediately cooled by air from the tube. The shape formed may be as shown in the section at the bottom of the figure which is a bearing jewel.

A knob 31 is arranged to be manually lifted against the action of a spring 34, which results in lifting the bottom 23 of the mold and pushing the formed article off by the spring 37 so that it drops into the air lock. When the parts are returned to the position shown in the figure, the article passes out through the vent 26. It should be understood that proper air pressure and adjustment of parts is necessary for successful operation of the device.

The following references are of record in the file of this patent: United States Patents: Re. 15,600, Lorenz, May 15, 1923; 1,742,098, Rankin, Dec. 31, 1929; 1,809,-793, Stenhouse et al., June 9, 1931; 1,831,548, Slick, Nov. 10, 1931; 1,845,491, Eckert, Feb. 16, 1932; 1,904,-977, Collins, Apr. 18, 1933; 2,038,519, Barnard, Apr. 28, 1936; 2,076,502, Moscini, Apr. 6, 1937; 2,130,702, Wadsworth, Sept. 20, 1938; 2,274,105, Stewart et al., Feb. 24, 1942; and 2,333,076, Stewart, Oct. 26, 1943.

Furnaces

Hartford Batch Feeder, Fig. 3. Patent No. 2, 471,336. This invention by Edward H. Lorenz was assigned to Hartford-Empire Company. It is an improvement on Patent No. 1,941,897 to Hiller which is the patent on the commercial Hartford batch feeder, the most noticeable difference being that the batch pushing member is thicker and provided with a packing to remove the batch from the pusher on the back stroke.

The figure shows a feed chamber 1 formed by a bottom 2 and side walls 3 and a carriage 11 mounted on wheels 12 and 13 so that it can be moved toward and from the tank 16. The operating mechanism seems to be quite similar to the batch feeders formerly made by the Hartford-Empire Co. A pusher 24 is curved on a radius from its center of movement about the shaft 30. A motor 8 drives a crank which acts through a rod 54 and

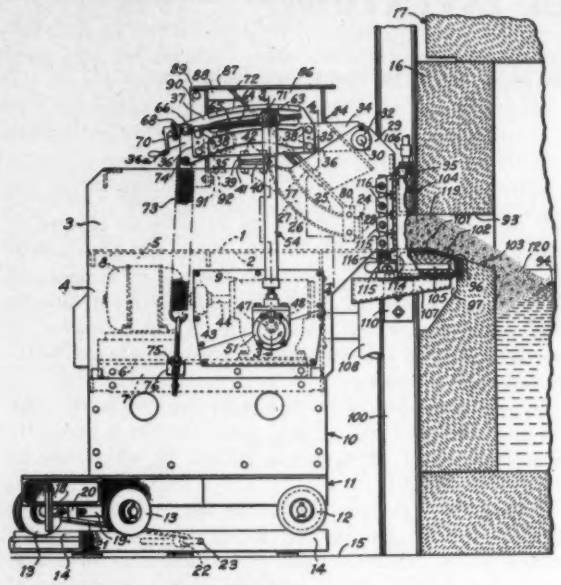


Fig. 3. Hartford Batch Feeder.

arms 34 to oscillate the pusher. The usual adjustable features and safety devices are provided.

One feature of this invention is the provision of a gasket or packing attached to the part 80 to wipe the batch off from the pusher on its idle stroke. The other feature is the thicker pusher 24 which is preferably made hollow so as to reduce the weight. Various cooling devices and details of mechanical construction are shown and described but these are not claimed in the patent.

The following references are of record in the file of this patent: United States Patents: 1,718,861, Huth, June 25, 1929; 1,941,897, Hiller, Jan. 2, 1934; and 2,327,887, Halbach et al., Aug. 24, 1943.

Glass Compositions

Lead-Titanium-Borate Glass. Fig. 4. Patent No. 2,472,-447. This is an invention of Kuan-Han Sun assigned to Eastman Kodak Company. The glass is harder than the ordinary high lead-containing glasses and it is useful for optical work, high dielectric substances and for decorative gem stones.

The preferred batch coming under this patent is as follows, giving the composition in weight and mole per cent and the optical properties of the resulting glass.

	Weight, per cent	Cationic, per cent
Lead Oxide (PbO)	78	44.4
Titanium Oxide (TiO_2)	12	19.1
Boron Oxide ($BO_{1.5}$)	10	36.5
n_D	2.0685	
v	17.7	

The patent calls attention to a glass known under the trade name of Vycor and described in the *Journal of the American Ceramic Society*, Oct. 1, 1944, pages 299-305. Fig. 4 shows the glass formation region of this new composition.

The invention is defined in Claim 1 of the patent as a borate optical glass having a refractive index greater than 2.0 and consisting of the fused heat reaction product of a batch comprising essentially titanium dioxide, 3 to 12 per cent by weight; lead oxide, 66 to 95 per cent; and boric oxide, 2 to 30 per cent.

The following references are of record in the file of this patent: United States Patents: 1,943,051, Berger, Jan. 9, 1934. Foreign Patents: 325,673, Germany, 1920.

Thallium-silicate Glass. Fig. 5. Patent No. 2,472,448. Kuan-Han Sun assigned this invention to Eastman Kodak Company. The composition is of particular value in optical work.

A glass composed of the oxides of titanium, silicon and thallium may be made and the figure shows the approximate limits of glass formation of such a system.

In the following table are given several specific examples of compositions coming under this patent, W indicating weight percent, and M mole percent. The table also gives the values of the refractive index for the D line (n_D) and the Abbe values (v), where known; and also in the column headed "Temp." the approximate melting temperature in degrees centigrade.

TABLE II

Example	$TlO_{0.5}$ W	$TlO_{0.5}$ M	TiO_2 W	TiO_2 M	SiO_2 W	SiO_2 M	$NaO_{0.5}$ W	$NaO_{0.5}$ M	n_D	v	Temp.
1	65.0	38.0	20.0	31.0	15.0	31.0	...	...	...	...	1,100
2	71.0	43.1	10.0	16.1	19.0	40.8	...	...	1.956	16.5	1,050
3	88.0	69.8	5.0	10.5	7.0	19.6	...	...	2.225	10.0	900
4	40.0	15.0	20.0	19.8	30.0	39.6	10.0	25.6	1.795	...	1,050
5	50.0	21.5	23.0	26.2	19.0	28.8	8.0	23.5	1.902	18.5	1,050
6	50.0	21.9	28.0	32.5	14.0	21.6	8.0	24.0	1.9334	17.8	1,050
7	55.0	26.4	25.0	31.8	15.0	25.4	5.0	16.4	...	...	1,100

The following references are of record in the file of this patent: U. S. Patent No. 1,607,817 to Dennis, dated Nov. 23, 1926 and Ser. No. 395,364 Berger et al. (A.P.C.) published May 11, 1943.

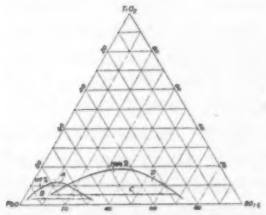


Fig. 4. Lead-Titanium-Borate Glass.

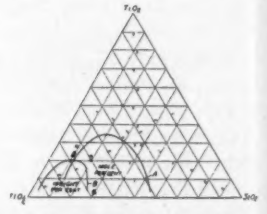


Fig. 5. Thallium-Silicate Glass.

Sheet and Plate Glass

Method of Bending Glass Plates. Fig. 6. Patent No. 2,470,461. This invention was assigned to Pittsburgh Plate Glass Company by Lloyd V. Black of Tarentum, Pa. The patent relates to the manufacture of curved laminated glass plates.

The molding apparatus 10 comprises a concave molding surface 11 and a plunger 12 having a convex molding surface 14 for pressing the glass plates 15 and 16. Another form of molding apparatus which may be employed is shown in Galey patent 2,021,180 dated Nov. 19, 1935.

Flat glass plates 15 are assembled on opposite sides of the intermediate plate 16. The intermediate plate 16

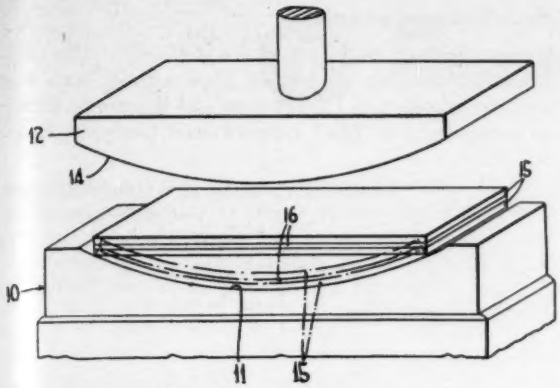


Fig. 6. Method of Bending Glass Plates

softens at a temperature of 50 to 100° lower than the temperature required to soften the other two plates so that any foreign matter which may be between the surfaces will be pressed into the softer glass without marring the surface of the plates 15 which are to be laminated later.

After the glass plates have been bent and cooled, the intermediate plate 16 is removed and the bent plates are laminated upon opposite sides of a sheet of organic plastic having the same thickness as the plate 16 which has been removed. There is practically no danger of setting up strains in the glass during lamination by the use of this method.

The following references are of record in the file of this patent: United States Patents: 1,716,350, Bart, June 4, 1929; 1,992,976, Watkins, Mar. 5, 1935; 2,021,180, Galey, Nov. 19, 1935; 2,314,325, Binkert, Mar. 23, 1943; 2,357,537, Orser et al., Sept. 15, 1944; and 2,377,849, Binkert et al., June 12, 1945.

Heated Window Glass. Fig. 7. Patent No. 2,470,509. Herman R. Marini, New Kensington, Pa., assigned this invention to Pittsburgh Plate Glass Company. The object of the invention is to provide a laminated glass having electrical conductors incorporated so that the glass may be heated to prevent the formation of frost.

The figure shows a laminated unit 10 made by the method which includes the steps of placing the plastic sheet 12 upon a glass plate 14 and on top of this, a sheet of cellophane or similar material which will not adhere to the plastic sheet 12. A cover plate 16 of polished glass is then pressed upon the several sheets as shown in the section. This assembly is then placed in an autoclave where it is treated in about the usual manner.

When the assembly is removed from the autoclave the elements 15 and 16 are removed which can be done as the sheet 15 does not adhere to the sheet 12. Fine strands 20 of conducting material are then placed on the sheet 12 and a final glass cover plate 21 is applied. These conducting strands 20 may be ribbons or wire which may be less than .005 of an inch in diameter. The final assembly is bonded by running it through nipper rolls and then placing it in an autoclave. Certain frames are described to assist in assemblying the parts. Electric current can then be run through the strands 20 to warm the glass when necessary to prevent frost.

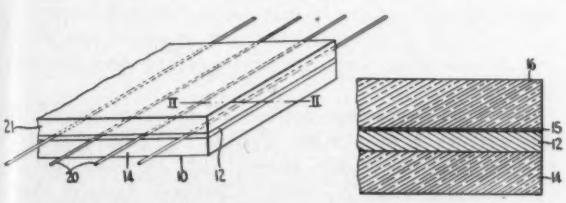


Fig. 7. Heated Window Glass.

The following references are of record in the file of this patent: United States Patents: 1,223,583, Hitchcock, Apr. 24, 1917; 1,741,562, Faguy, Dec. 31, 1929; 2,156,680, Dennison, May 2, 1939; 2,184,485, Challet, Dec. 26, 1939; 2,222,742, Ducret et al., Nov. 26, 1940; and 2,268,266, Ryan, Dec. 30, 1941.

Tube & Cane Machines

Machine for Making Precision-Bore Tubing. Fig. 8. Patent No. 2,470,234. Nathaniel Brewer, Newtown, Pa., assigned this invention to Fischer & Porter Company, Hatboro, Pa. The object of the invention is to make tubing from glass or like material having an exact inside diameter, which may be cylindrical or tapered.

The machine comprises a frame 20 having a housing 22 in which a spindle is mounted for rotation by means of gears 23 and 24 and a motor 25. A mandrel 27 is mounted in the spindle and the portion 29 is finished to the exact size of the inside of the tapered tube to be formed. A glass tube 32 is placed over the mandrel, the upper end being closed by a cap 36 and the lower end by a stuffing box 33 having connections to a suction line 37. A valve 38 opens and closes the connection to suction.

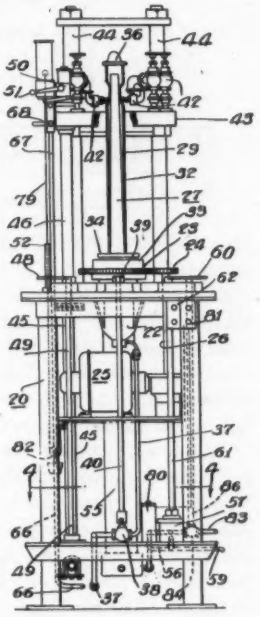


Fig. 8. Machine for Making Precision-Bore Tubing.

At the upper end of the tube 32 there are four burners 42 vertically movable on posts 44. Hydraulic mechanism is controlled by a handle 60 so that the burners may be raised or lowered automatically.

As soon as the upper part of the tube 32 has collapsed upon the mandrel when heated by the burners, the burners are lowered automatically but under close control of the operator. Thus the tube is gradually collapsed upon the mandrel and takes its shape which may be formed as desired. There are many auxiliary controls described in the patent and several modifications are shown. In any case, the result is a tube having the desired interior contour of exact dimensions.

The following references are of record in the file of this patent: United States Patents: 1,301,714, Kueppers, Apr. 22, 1919; 1,999,525, Morscholz, Apr. 30, 1935; 2,368,169, Smith, Jan. 30, 1945; 2,368,170, Smith, Jan. 30, 1945; and 2,423,113, Pfleghar, July 1, 1947. Foreign Patents: 497,486, Great Britain, Dec. 19, 1938.

Tube End Forming Machine. Fig. 9. Patent No.

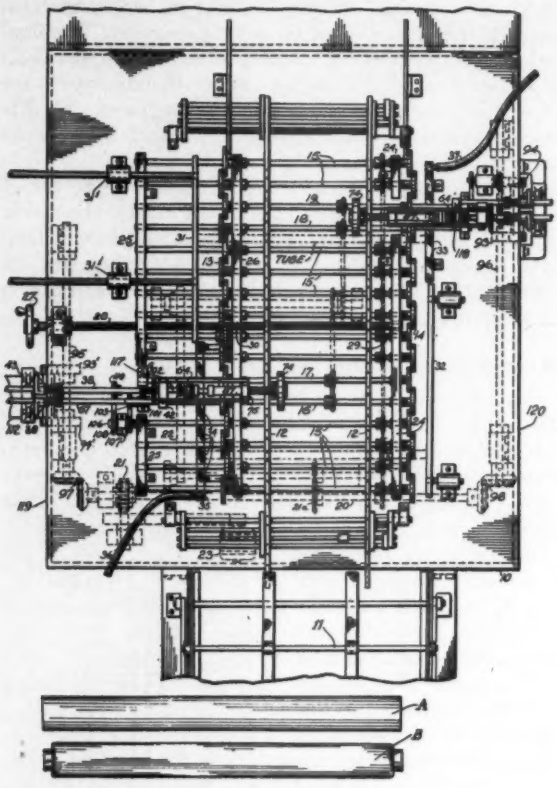


Fig. 9. Tube End Forming Machine.

2,470,923. This is another of the numerous inventions of Charles Eisler. It relates particularly to a machine for forming both ends of a fluorescent tube at the same time. This is a great advantage over the previous method of forming one end and then running the tube through the machine a second time to form the other.

The lower part of the figure shows the tube before and after forming and the upper part shows the machine by which the operation is performed. The machine comprises a table 10 having a hopper 11 at one end from which the open ended tubes are delivered to notched rails 12 by which they are advanced to the operating stations. The tubes are rotated at the proper times by discs 13 on the adjustable side 119 of the machine and by discs 14 on the fixed side of the machine. The usual chain drive is provided to rotate the discs.

The projecting ends of the tube are heated by burners 33 and 34. A shaft 38 carries a forming die 39 which is moved into and out of the end of the shaft at which time rollers act to shape the end of the tube as shown in the lower part of the figure. A similar device acts to form the other end of the tube. The whole machine is adjustable so as to handle tubes of various diameters and lengths and the operation is completed on one run through the machine.

The following references are of record in the file of this patent: United States Patents: 645,189, Rudolph, Mar. 13, 1900; 928,618, Wilzin, July 20, 1909; 1,914,205, Hooper et al., June 13, 1933; 2,234,302, Dichter, Mar. 11, 1941; 2,284,089, Hahn et al., May 26, 1942; 2,364,673, Stuckert et al., Dec. 12, 1944; and 2,394,115, Snyder, Feb. 5, 1946.

Miscellaneous Processes

Glass Sealing Alloy. Patent No. 2,471,079. This alloy is for the purpose of making glass-to-metal seals and it is the invention of Carl B. Post and Warren S. Eberly who assigned it to The Carpenter Steel Company, Reading, Pa.

These inventors have discovered that the addition of 0.50 to 2.00 per cent by weight of columbium to certain iron nickel alloys creates new alloys which are substantially gas-free during glass-to-metal sealing operations. The new alloys may be identified as to composition by the following analysis:

	Percent by weight
Carbon (maximum)	0.07
Manganese	0.50 to 2.00
Silicon	0.25 to 1.00
Nickel	30 to 60
Columbium	0.50 to 2.00

All or substantially all of the balance is iron and incidental impurities.

The following references are of record in the file of this patent: United States Patents: 2,162,489, Mathies et al., June 13, 1939; 2,239,423, Hull, Apr. 22, 1941; and 2,266,481, Talbot, Dec. 16, 1941. Foreign Patents: 679,794, Germany, Aug. 15, 1937.

Device for Inspecting Glass Articles. Fig. 10. Patent No. 2,468,663. Thomas D. Green of West Harford, Conn., assigned this invention to Hartford-Empire Company. The device is particularly adapted for the examination of ware of low transparency, such as amber glass insulators, where the defects are not readily visible under usual light conditions.

The drawing shows a base 1 carrying a vertical post 4 on which an upper part 5 is adjustably secured. This upper part has a loading table 10 including a chamber 11. The insulator 22 is placed upon a support 23 which may be elevated to place the insulator inside an inspection box 39 where it is exposed to the light from a bulb 47. A pair of shields are provided, one between the lamp and the insulator and the other between the insulator and the observer. These shields are cut out in the middle to correspond to some extent with the shape of the insulator so that the light passes through the central portion only. The ware is rotated during inspection by a motor 69.

In addition to the light projected through the entire insulator, a light bulb 72 (shown in dotted lines) is arranged to be inserted into the socket of the insulator. The operation is automatic after the insulator has been placed in the dotted line position and the switch 121 has been depressed by the operator's foot or by the use of a hand operated switch. In this way a thorough inspection may be made of dense articles, such as amber insulators, and defects which would otherwise escape detection may be found.

The following references are of record in the file of this patent: United States Patents: 715,393, Koehler, Dec. 9, 1902; 1,006,455, Barnes, Oct. 24, 1911; 1,030,422, Muench, June 25, 1912; 1,204,664, Jackson, Nov.

(*Continued on page* 412)

Research Digest

Hygroscopicity of Soda-Lime-Silica Container Glasses

The measurement of the hygroscopicity of powdered glasses was shown by Hubbard (of the Bureau of Standards) to be a practical means of evaluating the serviceability of optical glasses. Using the usual tests, such glasses usually came out with very low (or poor) chemical durabilities but yet they stood up well in actual service. As a result, Hubbard developed this special procedure for the evaluation of the weathering resistance.

Many ways of measuring the chemical durability of glasses have been proposed. The current methods used in the United States are concerned chiefly with determining the extractable alkali in the glass as a measure of its chemical durability and they have proved to be quite useful. Yet a method which accelerates the attack on the glass surfaces simulating moist atmospheric reactions would be a helpful tool for the storage of glass in a damp basement, in a warehouse over water or in a humid climate constitutes an extremely severe test of its quality. As the hygroscopicity test may give such information in a few days, Matson (*Journal of the American Ceramic Society*, April 1949) reports on the development of a test procedure based on the method proposed by Hubbard. This test procedure was then used to evaluate an extensive series of commercial soda-lime glass bottles and laboratory melts of many compositions.

The test procedure, in brief, is as follows: One-gram samples of dried powdered glass that have passed through a 200-mesh sieve are placed in uncovered low-form weighing bottles and exposed in a humidity cabinet for three days at 100°F. (98 per cent relative humidity). They are then reweighed. The hydroscopicity value is expressed as percentage gain in weight. Samples are then dried at 120°C. for 24 hours and again weighed to determine their permanent gain in weight. The powdered glasses can be examined under a petrographic microscope for evidence of surface reaction products. The chemical durability of the crushed-glass samples was also determined by the revised A.S.T.M.-U.S.P. method.

From the results obtained, it was concluded that: Container glasses of reasonably good powder durability will gain up to 0.65 per cent in weight in the humidity cabinet under the test conditions. Other glasses may gain as much as 1.7 per cent. Powder durability and hygroscopicity tests have a direct correlation for glasses containing 18 per cent Na_2O or less. In simple soda-dolomitic lime-silica glasses higher in soda, an increase in CaO·Mgo at the expense of SiO_2 increased the hygroscopicity but had little effect on powder durability. In these glasses, however, there was an increase in alumina content which may have been the dominant factor. The compositional factors that affect hygroscopicity follow:

1) The Na_2O-Al_2O_3 ratio; Na_2O increases and Al_2O_3 decreases the hygroscopicity. 2) Straight lime glasses are more hygroscopic than those made with dolomitic lime when the remainder of the glass composition is identical in both glasses. Lime glass shows attack more rapidly than dolomitic lime glass of the same composition and has a greater permanent gain in weight.

3) Small percentages of B_2O_3 reduce hygroscopicity. 4) Hygroscopicity is reduced by $BaSO_4$. This action may be due chiefly to the SO_3, which can cause greater volatilization of Na_2O and added corrosive action, resulting in increased Al_2O_3 in the glass. This change in Na_2O and Al_2O_3 would reduce the hygroscopicity.

Since hygroscopicity parallels fairly well the powder durability results for container glasses and requires three days for the determination of its value, the test is of secondary importance for such glasses once its range has been established. It furnishes an excellent method for determining the rate of attack by humid air from the permanent gain in weight of samples dried after the high-humidity test. The procedure accelerates the formation of reaction products on glass making such quickly available for microscopic study.

Gases in Glass

The problem of the solubility of gases in glass during the fining process is discussed by Dietzel (*Glashütte*, July 1948) who shows that it is partly a physical question and partly one of chemical gas reactions. Examples of chemical gas reactions are the dissolving of water in the glass melt by the formation of OH^- ions, the oxidation of FeO by oxygen, etc. The physical problem of gas evolution is one of the formation of a new surface in the interior of the melt, for which high energies must be made available. These energies can be determined by electrochemical measurements. In a borax glass to which 1 per cent CeO_2 was added as the fining agent, the initial inner pressure of the oxygen was extrapolated to 10^4 to 10^5 atm., the same amount calculated by A. Smekal for the molecular tensile strength of glass at normal temperature. This high excess local pressure explains the tension which induces the gas diffusion in the melt and produces the rapidly growing gas bubbles. For the speed of the fining process, the pressure differential and, therefore, the diffusion gradient are essential.

At the end of the fining, pronounced gas under pressure was observed in the experiments, which is explained by the resorption of oxygen by Ce_2O_3 at a lower temperature (800°C) than that of maximum fining (900°C). Phenomena observed in this borax glass-CeO_2 system are also valid if sulphate or arsenic is used for fining.

With the use of sulphate, however, it should not be overlooked that by its decomposition two gases (SO_2 and O_2) are formed, each having different diffusion rates and different molecular diameters, the SO_2 also showing a considerable dipole moment which retains it in the glass network. A differentiated phase may therefore be observed in the gas phase which will bring about a persistence of bubbles during the cooling since SO_2 and O_2 are no longer present in the correct stoichiometric ratio for a complete resorption as sulphate. This condition can be overcome only by increasing the temperature which will wash the gas out.

PAUL HERSHFIELD NEW PRESIDENT OF MISSISSIPPI GLASS

At a meeting of the Board of Directors of the Mississippi Glass Company, it was unanimously voted to offer the presidency of the company to Paul I. Hershfield. He has accepted and was formally elected at a special meeting of the Board on July 11th.

For many years, Mr. Hershfield has been associated in various managerial capacities with the Anchor Hocking Glass Corporation, and currently is acting as Administrative Control Manager.

Mr. Hershfield succeeds Dr. John C. Hostetter, who was elected to the newly created position of Chairman of the Executive Committee, and who will continue to serve as Chairman of the wholly owned subsidiary, Walsh Refractories Corporation. Dr. Hostetter will act as Director of Technology for both companies.

MORE ON "RENDERING SURFACES ANISOTROPIC"

Editor
The Glass Industry

In reply to the article "On Rendering Surfaces Anisotropic" by Dr. C. D. West published in the GLASS INDUSTRY for May, I should like to state the following:

Dreyer patent No. 2,432,867 was allowed by the U.S. Patent Office only after an official determination of priority of invention as against Mr. Land of Polaroid Corporation. In that proceeding, Polaroid Corporation took the position that Dreyer's polarizer could not work.* That conclusion was based on their own study of Zocher's work which they testified proved it inoperative for practical purposes and an assumption that Dreyer's principle was the same as Zocher's. The Patent Office recognized that they are not the same. Practical experience has shown that Dreyer's principle is sound and operative. His Polacoat film is a commercial reality of proven superiority in many respects over competitive film. Apparently, however, Dr. West still clings to his old fallacy that Dreyer is merely using Zocher's inoperative method.

Although he refers to dichroic "particles" which is characteristic of Zocher's work, the only particles shown in his microphotographs are the six dirt particles which show best in his Figure 1.

We would appreciate it if you would publish these facts.

John Dreyer
Polacoat Incorporated
Cincinnati, Ohio

* Transcript of Record, U.S. Court of Customs and Patent Appeals Docket, Dreyer v. Land, No. 5075 Interference No. 79,900, page 416, third paragraph, reads:
"Land has already taken the position before the Patent Office that the Zocher process is inoperative for practical purposes."

SUPREME COURT TO HEAR CASE OF DISBARMENT

The Supreme Court will deliver the final legal judgment on a case that has disturbed the glass industry and involved its patent attorneys since 1926.

The high court has agreed to review a ruling by the U.S. Court of Appeals for the District of Columbia that set aside the patent office's 1944 disbarment of three prominent glass industry lawyers on charges of gross misconduct 18 years previously.

The Court of Appeals had reversed a 1947 ruling of District Judge James W. Morris, who refused to annul the disbarment of Henry W. Carter, Toledo, 82-year-old retired vice president and general counsel of Owens-Illinois Glass Co.; Roswell F. Hatch, 66, of the Hartford-Empire Co., Hartford, Conn., and Vernon M. Dorsey, 80, Washington patent attorney.

The patent office then appealed to the Supreme Court, which will take up the case at its new term starting next fall.

These proceedings arose from testimony in the glass container anti-trust trial in Toledo in 1941 concerning use of a "ghost-written" article to help obtain a patent in 1926.

SHIPPING CONTAINER INSTITUTE COMPLETES FREIGHT STUDY

The Shipping Container Institute has announced that its three-year study of the causes of rail freight loss and damage to merchandise shipped in fibreboard boxes has been brought to a conclusion.

With the completion of this program, the Institute has successfully accomplished the purpose for which it was organized in 1946 and formal steps for its dissolution are being taken. The decision was announced at a recent meeting where T. J. Gross, the retiring Managing Director, made his final report summarizing the results.

In the program, over 1,000 carefully supervised test shipments were made involving more than 1,000,000 boxes. Shipments were inspected both at the time of loading and at points of destination. Representative samples of the boxes in each lot were thoroughly tested and analyzed by the most modern laboratory techniques, in cooperation with the Institute of Paper Chemistry, Appleton, Wisconsin. Every principal commodity moving in fibre boxes was included and shipments were made to virtually every part of the United States.

FLAT GLASS TELEVISION SHOW

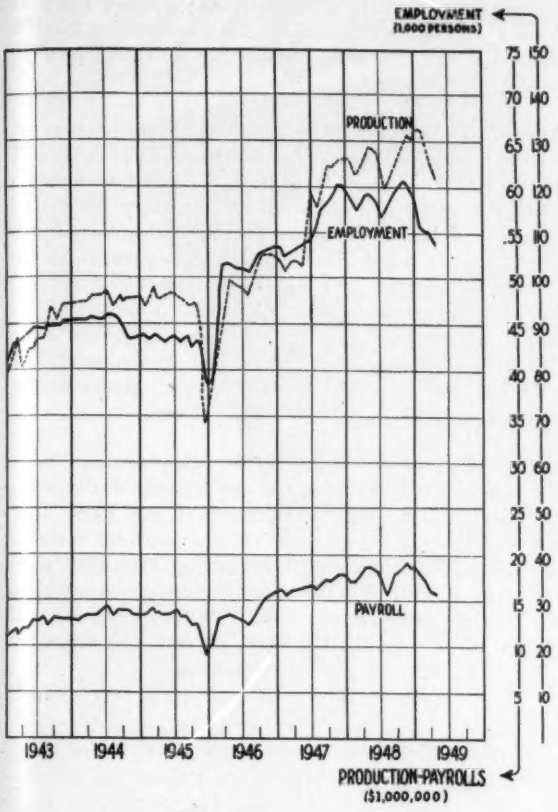
Paul T. Mattimoe, of the research department of Libbey-Owens-Ford Glass Company, took part in a recent television show on flat glass in Detroit.

The presentation provided a trip into several of the L-O-F plants by way of motion pictures so that viewers saw the charging of huge glass tanks, the drawing of window glass and casting of plate glass, and the ultimate assembly of some of the products into safety plate glass, large plates for store windows, Thermopane and the packing of Vitrolite, window glass and other products.

The 45-minute show was one of an educational series and was developed by Libbey-Owens-Ford Glass Company on behalf of the Detroit section of the American Chemical Society.

CURRENT STATISTICAL POSITION OF GLASS

GI THE GLASS INDUSTRY'S INDEX



Activity in the glass industry during the month of April 1949 continued its downward trend to reach an estimated $61,350,000. This represents a decrease of about 2½ per cent from the previous month's production total of $63,000,000. During April 1948, the Production Index indicated an estimated $64,500,000, which is about 4 per cent above April this year. At the close of the first four months of 1949, production in this glass industry has reached an estimated total of $257,350,000, as compared with $253,000,000—1½ per cent less than for the corresponding period this year.

Employment and payrolls: Employment in the glass industry for the month of April 1949 fell off slightly more than 1 per cent to reach 107,900. During March 1949, employment was 109,400, and during April 1948, it was 117,900. This is about 8 per cent above April this year.

Payrolls for the month of April 1949 were estimated to be $16,500,000. This is about 2½ per cent below the previous month's payrolls of $17,000,000. During April 1948, payrolls were an estimated $18,500,000, which is about 10 per cent above April this year. Thus far in 1948, glass manufacturers have paid out an estimated payroll total of $69,850,000, as compared with $72,000,000 reported for the corresponding period in 1948—a difference of close to 3 per cent.

Glass container production for the month of May 1949 showed the first spurt in several months and reached a total of 7,601,647 gross. This is 8 per cent above the previous month's 7,035,075 gross. Production of glass containers during the month of May 1948 was 8,824,982 gross, which is about 13 per cent above May this year. Total glass container production at the close of the January-May 1949 period has reached 35,752,404 gross, as compared with 42,045,946 gross during the same period in 1948—a difference of about 14 per cent.

Shipments for the month 1949 also perked up considerably and were reported to be 7,861,591 gross, as compared with 7,050,577 gross the previous month—an increase of 11½ per cent. During May 1948, shipments were 8,198,417 gross, or 4 per cent above May this year.

GLASS CONTAINER SHIPMENTS
(All figures in Gross)

	May 1949
Narrow Neck Containers	
Foods	697,106
Medicinal & Health Supplies	894,281
Chemicals, Household & Industrial	537,116
Beverages, Returnable	804,435
Beverages, Non-returnable	8,689
Beer, Returnable	238,381
Beer, Non-returnable	324,004
Liquors	591,004
Wines	243,452
Toiletries & Cosmetics	414,446
Sub-total (Narrow)	4,752,914
Wide Mouth Containers	
Foods	1,841,104
Dairy Products	227,237
Home Canning	268,400
Medicinal & Health Supplies	216,485
Chemicals, Household & Industrial	94,877
Toiletries & Cosmetics	137,294
Packers' Tumblers	126,385
Sub-total (Wide)	2,911,782
Total Domestic	7,664,696
Export Shipments	196,895
Total Shipments	7,861,591

GLASS CONTAINER PRODUCTION AND INVENTORY
(All figures in Gross)

		Production May 1949	Stocks May 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,536,154	3,311,896
	Wide Mouth	2,401,779	2,508,168
Dairy Products		238,768	254,476
Home Canning		*110,919	808,483
Beverages, Returnable		864,046	732,306
Beverages, Non-returnable		10,795	8,347
Beer, Returnable		188,341	679,951
Beer, Non-returnable		259,200	296,720
Liquors		579,971	439,088
Wines		257,633	284,449
Packers' Tumblers		154,041	134,288
Total		7,601,647	9,458,172

* This figure represents Fruit Jars only.

TAILORED for the GLASS INDUSTRY

Malleables for plugging moulds will pein readily. We have above sizes available for immediate shipment. Other bars available in sizes you want. Your inquiry will bring complete information on Alloy Iron Castings, for Plungers, Ring Sticks and Guide Rings.

The HAVEN MALLEABLE CASTINGS CO.
DANE & KNOWLTON STS. PHONE Kirby 3581
CINCINNATI 23, OHIO

Total glass container shipments at the close of the first five months of 1949 have reached 34,634,409 gross, as compared with 41,152,015 gross shipped during the corresponding period in 1948. This represents a difference of about 15½ per cent.

Stocks on hand at the close of May 1949 dropped to 9,458,172 gross from the 9,763,334 gross on hand at the close of April. Stocks on hand at the close of May 1949 were 8,422,850 gross.

Automatic tumbler production jumped 13½ per cent for the month of May 1949 to reach a total of 5,242,474 dozens. This is an increase over the previous month's 4,620,563 dozens. Production during May 1948 was 5,277,937 dozens. Shipments for May also turned upward to reach 5,054,771 dozens. This represents an increase of 3 per cent over April's shipments of 4,904,746 dozens. Shipments during May 1948 were 5,277,119 dozens. Stocks on hand at the close of May were 8,614,609 dozens, about 4 per cent above stocks of 8,270,234 dozens at the close of April. Stocks at the close of May 1948 were 8,398,385 dozens.

Table, kitchen and household: Manufacturers' sales of machine-made table, kitchen and household glassware were 3,672,072 dozens for the month of May 1949. This is a jump of 12½ per cent over the previous month's sales of 3,263,948 dozens. Sales during May 1948 were 3,846,623 dozens. Manufacturers' sales at the close of the 12-month period during May 1949 totalled 39,718,030 dozens. At the close of the 12-month period ending May 1948, sales had been 42,827,498 dozens.

PRODUCTION OF GLASS IN THE U.S.S.R.

The absolute amount of the production is not directly revealed, but the output of glass in January-October 1948 was 128.8% of the corresponding output in 1947 and 134.5% of the output during January-October 1940, when it was almost twice as great as in 1913.

The daily output per square meter of the working part of glass furnaces was 542 kg. in 1947, 575 kg. in January-March 1948, 598 kg. in April-June 1948 and 646 kg. in July-Sepember 1948. This acceleration presumably is due to the thin-layer introduction of batch, see page . . . this issue of THE GLASS INDUSTRY. The highest output achieved was 834 kg.

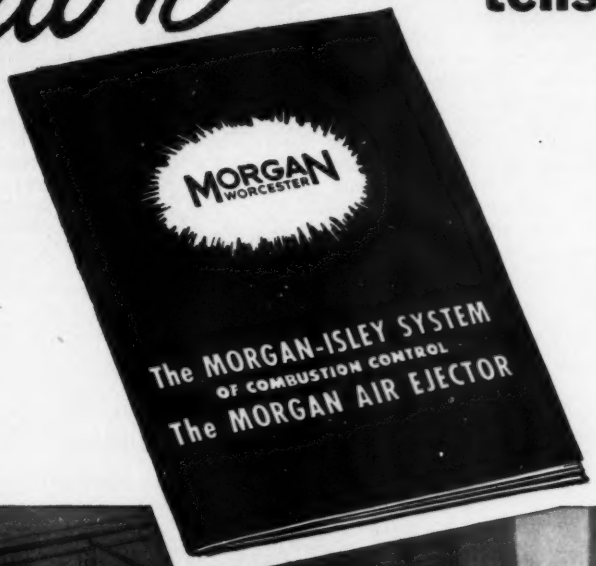
The rate of withdrawal of Fourcault glass increased from 55.2 meter/hr. in 1947 to 59.2 meter/hr. in the first quarter of 1948, 60 meter/hr. in the second quarter and 62.4 meter/hr. in the third quarter.

In 1948, production of polished glass completely recovered after the war damage, the production of toughened glass first reached commercial tonnage, the first consignment of hollow glass blocks was completed, and large scale manufacture of foamglass and of special objects from glass filaments was started.

The above data were taken from *Steklo i Keramika* (Glass and Ceramics), No. 11 and 12, 1948.

• Laben Melnick, B.S. Chem. Pitt 1948, has been appointed Alexander Lowy Memorial Fellow in Chemistry in the University of Pittsburgh, effective July 1. He will devote himself to research in glass.

This *New Bulletin* tells you how to get:



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. . . through the Morgan-Isley Furnace Control System. It clearly establishes the superiority of the Morgan-Isley System over natural draft. Send for your copy *today* . . . on your company letterhead, please.

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NEW EQUIPMENT AND SUPPLIES

AUTOMATIC SAMPLERS FOR CONTINUOUS PROCESSES

Hardinge Company, Inc., York, Pa., has secured manufacturing and sales rights to a sampler which is being placed on the market as the Hardinge Automatic Sampler.

The sampler takes periodic "cuts" (or samples) from a stream of moving material, either wet or dry, at any stage in a continuous process. It is particularly adapted to the stone products, ceramics, mining, chemical and allied industries.

The unit is entirely automatic and can be set to operate periodically at a variety of time intervals from 5 to 60 minutes. When activated by a time switch, the sample cutter moves horizontally at a constant speed across the stream of moving material, diverting a representative sample into a sampling launder or container. The cutter movement is controlled to avoid stroke speed and length variation during each cutting operation

NEW BOILER BURNER

North American Mfg. Company, 4455 East 71st Street, Cleveland 5, Ohio, has announced the addition of a new, self-contained boiler gas burner to its production line.

The new burner, known as the North American Series 115 Boiler Burner, is a package unit offering simplicity of installation to either old or new boiler settings. Two sizes are available at present: the 115-2.5 for two and one-half million BTU input and the 115-5 for five million.

All combustion air is furnished through the burner by a blower which is an integral part of the burner. This gives complete fuel-air ratio control and assures the maximum heat output of any fuel used. Furnished complete with a control panel incorporating all safety devices, the unit with modulating control is entirely automatic.

B&L MICROSCOPE ATTACHMENT

Bausch & Lomb Optical Company, Rochester 2, New York, has developed a microscope attachment that provides three types of reflected illumination: bright field, dark field and polarized.

Known as the Tri-vert Illuminator, it can be readily attached to the body tube of any standard mon-objective microscope for the examination of opaque or semi-opaque specimens. The change-over from dark field to bright field illumination is instantaneous and is controlled by a lever. A Polaroid polarizer and cap analyzer provide for polarized light examinations.

Vertical illumination is attained by a glass reflector plate which is coated with titanium oxide. The periphery of the plate is aluminized for the dark field beam, and has a clear center for bright field and polarized light. A quadruple revolving nosepiece is employed to accommodate four objectives of patented design. The objectives are mounted in an illuminating cell of transparent plastic.

The reflector, as well as the remainder of the attachment's optical parts, is completely enclosed, affording protection against breakage and dirt seepage.

Designed specifically to provide rapid comparison studies under three types of illumination, the attachment, which in no way impairs the focusing of the microscope, is expected to have wide application in biological and metallurgical research as well as in the ceramics, plastics, textile, paint and other fields.

NEW CARBIDE GLASS DRILL

Super Tool Company, 21650 Hoover Road, Detroit 13, Michigan, has announced a new line of carbide tipped glass drills in sizes from 1/8" to 1/2".

A feature of the glass drill is the two flute design which not only means easier sharpening, but results in lower prices, according to the manufacturer, particularly in the smaller sizes.

NEW TUKON MICRO-HARDNESS TESTER

Wilson Mechanical Instrument, Inc., an associate company of American Chain & Cable Company, 230 Park Avenue, New York 17, New York, has introduced a new Tukon Microhardness Tester, Model MO.

Mechanically operated, it is recommended for those interested in light load testing where there is not sufficient testing to warrant a fully automatic model. The tester applies loads of from 1 to 1000 grams and may be used with either the knoop or 136 degree diamond pyramid indenters. Load is applied under dash pot control, speed of which may be varied from less than .040" per minute to as fast as testing permits without impact influencing the results. Both rate of application and duration of applied load may be controlled. A feature of the Model MO is a special arrangement for removing the load without the operator having to touch the instrument until the indenter is out of impression.

Focusing the impression under the microscope is accomplished through the elevating unit with vernier adjustment. The load is applied in a manner which eliminates the necessity of bringing the elevating screw to any reference marks, trial settings, etc.

CATALOGUES RECEIVED

Ladeen Manufacturing Mfg. Company, 1600 S. San Pedro St., Los Angeles 15, Calif., has issued technical Bulletin CS 449 describing bin valves for controlling powdered materials which are operated with pneumatic cylinders. The operation and cylinder equipment are discussed and an installation is illustrated.

Chas. Taylor Sons Company, P. O. Box 58 Annex Station, Cincinnati 14, Ohio, is distributing its Bulletin 202.

The 15-page illustrated bulletin discusses properties and applications of Taylor Zircon special refractories. The refractories are recommended for the construction of aluminum open-hearth melting furnaces, as crucibles for melting and refining platinum and similar alloys which are subject to contamination when melted in graphite and for the glass, refining and chemical process industry where a highly acid refractory having a softening point about 3600°F. is required.

Bausch & Lomb Optical Company, Rochester 2, New York, has released a bulletin featuring its Abbe –56 Refractometer.

The bulletin features a full page photograph of the instrument with text material describing it and its mechanical features, such as a spare prism set, protective housing, internal transparent glass scale, fixed-position eyepieces, prism illumination, operating mechanism, telescope system and thermometer. A brief review of applications and price list are included in the bulletin.

R. S. Aries & Associates, 26 Court Street, Brooklyn 2, New York, is distributing a leaflet featuring its chemical engineering plan.

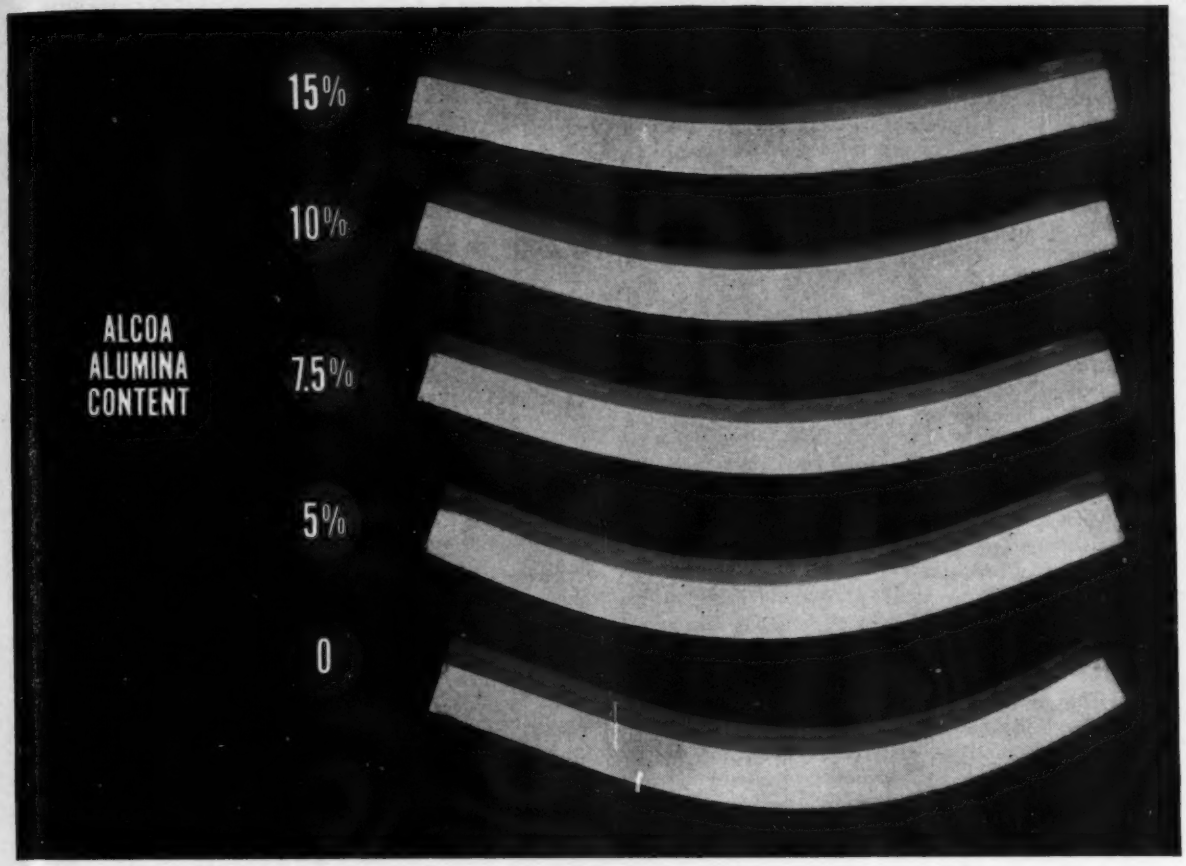
In addition to information concerning the company's services, the pamphlet lists its personnel and the fields in which it has aided in development programs.

National Pallet Corporation, Oliver Building, Pittsburgh 22, Pa., has just published a new catalogue entitled "National Pallets," which illustrates and describes many types of wood pallets made by the company.

Included in the catalogue is a map showing the location of the company's mills throughout the country and a list of cities where sales representatives are located.

Morgan Construction Company, 15 Belmont Street, Worcester 5, Mass., has issued a bulletin on their combustion control system. The pamphlet illustrates both the Morgan-Isley furnace control system and the Morgan ejector.

It discusses the use and the characteristics of the two types of combustion controls in detail and the characteristics of the mechanically produced draft and forced air supply in detail. The bulletin also gives a list of the various installations in glass furnaces and steel mills.



See what a difference a little Alcoa Alumina makes

All five of these ceramic specimens were fired at 2320° F. in about 30 hours. Cone 10 averaged 5 o'clock at the end of the firing. *Yet look at the difference in deformation.* The ALCOA ALUMINA content ranged from 0% (bottom specimen) to 15% (top specimen). *The addition of 15% Alcoa Alumina resulted in a 38% decrease in deformation!*

ALCOA ALUMINA adds strength to refractories, porcelains and other types of ceramic bodies. The more ALCOA ALUMINA you add, the higher the temperature a refractory can withstand. But even at "moderate" temperatures, a *little* ALCOA ALUMINA makes a marked difference, as shown by these test bars.

ALCOA ALUMINA improves refractories and other ceramics in a number of ways. It gives them:

- **Better stability under load at high temperatures.**
- **Lower coefficient of expansion.**
- **Higher resistance to both thermal and mechanical shock.**
- **Negligible porosity and shrinkage.**
- **Better resistance to spalling at high temperatures.**
- **Better resistance to corrosive slags and gases.**

WE DO NOT MAKE REFRACTORIES or other kinds of ceramics. But more and more, leading manufacturers are adding ALCOA ALUMINA to their mixes to improve the performance of such products.

We have considerable data concerning the value of ALCOA ALUMINA in ceramics. Some of this information may be of interest to you. Let us discuss it with you. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1467 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA

ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS
ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

HYDRODYNAMIC BREAKAGE . . .
(*Continued from page* 383)

is substantially decreased by internal damage, and as water hammer is an internal impact it seems certain that external damage opposite the point of impact would also bring about substantial strength reductions.

It is our opinion that performance differences from pack to pack are much more likely to be due to variations in the contents (gas content, pulp content and distribution, etc.) than in the glass containers involved.

Summary

The present state of knowledge of the practical situation with respect to hydrodynamic breakage is summarized briefly below.

1. High vacuum is usually a contributing factor. Under normal trade conditions the higher the vacuum the greater the likelihood of breakage.

2. Efficient deaeration can be a contributing factor. In general the less gas trapped in the product the greater the likelihood of breakage.

3. Inverted packing when practicable decreases the likelihood of breakage at least with products such as catsup in narrow necked bottles.

4. The amount of added cushioning obtainable in commercial practice affords little if any protection against hydrodynamic breakage.

5. At present no completely reliable tests exist for the resistance of bottles to hydrodynamic breakage.

6. Differences in susceptibility to hydrodynamic breakage are largely in the product and, with the possible exception of badly scratched or damaged bottles, the role of the container is relatively unimportant. If serious breakage occurs and the bottles are not judged otherwise defective, it is a good indication of an extremely susceptible pack.

While no simple solution to the problem has been found, it is believed that a knowledge of the above facts should be sufficient to cope with most situations which are likely to arise and that with reasonable care it should be possible to keep this type of breakage within tolerable limits.

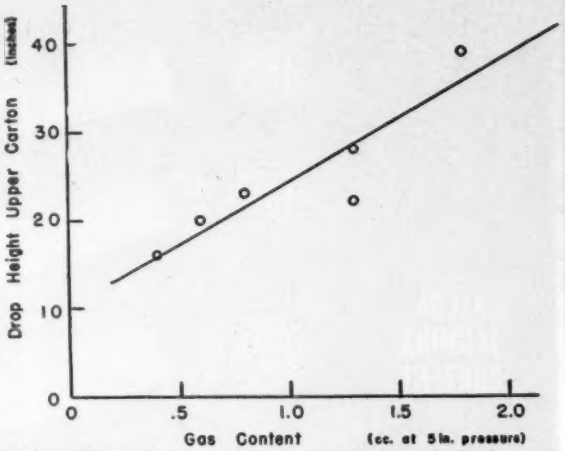


Fig. 5. Effect of gas content on resistance to hydrodynamic breakage in stacked-carton drop test. Height of drop of upper carton to break three bottles of 24 in middle carton vs. volume of gas trapped in contents.

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BORAX . . . the economies of a B_2O_3 addition should not be measured solely by the cost of the raw material but by an evaluation of the improvements and beneficial effects resulting from its use.

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Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

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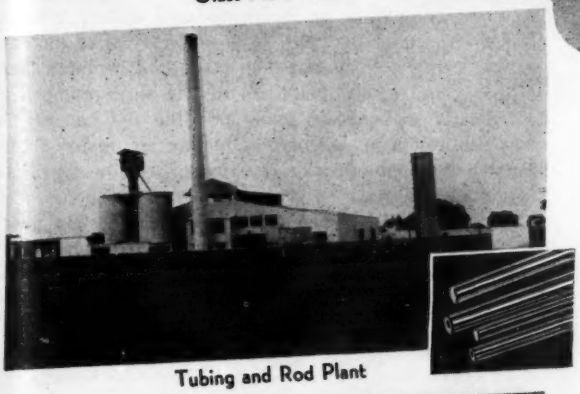
MODERN GLASS FACTORY INSTALLATIONS AND EQUIPMENT TO SUIT *YOUR* NEEDS

Glass Fibre Plant



Tubing and Rod Plant

Glass Containers Plant

Single Unit Window Glass Plant

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Our newly improved glass fiber drawing machine will meet your demands if you require the production of high quality glass fibers of varying thicknesses.

We specialize in the construction of modern and complete glass plants embodying advanced engineering design, automatic methods, and machinery to suit local conditions. We also furnish partial equipment for plant modernization or renewal.

Glass factory installations supplied by us are operating successfully in many countries of the world.

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For better, more efficient production . . . elect **REMMEY CRYSTALITE,** feeder parts to do the job.

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Long-lived, firm closure at tube seat . . . close-tolerance machined for uniformly accurate location in feeder.

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Retain shape longer for continued, more accurate control of glass gob.

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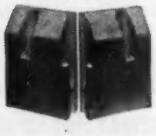
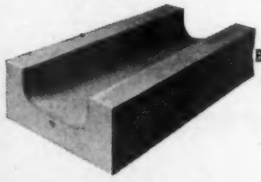


BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.



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Uniformity, accuracy, and structural quality combine for longer productive life.

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Dependable Refractories

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ANTI-TRUST SUIT AGAINST GLASS COMPANIES ENDS

A consent decree without a trial ending the anti-trust suit against Owens-Corning Fiberglas Corporation, Corning Glass Works and Owens-Illinois Glass Company was signed in Federal Court by U. S. District Judge Frank L. Kloeb.

Some years ago, before the suit was entered, the Fiberglas Corporation had listed its patents for licensing to anyone who wanted to go in the glass fiber business. The Department of Justice complaint was filed on September 10, 1947 charging the three companies with monopoly in the glass fiber field. The government asked that the court divest Owens-Illinois and Corning Glass Works of their stock interests in the Fiberglas Corporation and split up the Fiberglas Corporation according to a plan to be approved by the court.

Dismissal of the government's suit was sought by the three companies in a consolidated answer filed in Toledo November 1, 1948. The answer denied any activities designed to monopolize trade and declared that, on the contrary, the activities of the three companies had greatly assisted or made possible the commencement, enlargement and strengthening of many enterprises which manufacture, fabricate, sell or distribute glass fiber products.

Although enjoining the defendants from certain practices, the decree just signed does not require that Owens-Illinois and Corning Glass Works divest themselves of their stockholdings in Owens-Corning Fiberglas Corporation.

Major provisions of the decree requires Owens-Corning Fiberglas Corporation to issue licenses at reasonable royalties under certain patents, as well as under future patents that may be acquired within the next five years relating to the manufacture of glass fibers and glass fiber products, and to issue royalty-free licenses under certain other patents; to make available to licensees manuals describing the production of glass fibers and fiber products under licensed patents; to confine membership on its Board of Directors to persons not affiliated with Owens-Illinois Glass Company or with Corning Glass Works; to cancel foreign license agreements and to refrain from entering into similar agreements in the future.

In addition, all three companies are restrained by the decree from acquiring any financial interest in other companies making or selling glass fibers. Both Owens-Illinois Glass Company and Corning Glass Works are required to refrain from controlling or directing the commercial policy of Owens-Corning Fiberglas Corporation, but are allowed to retain their stockholdings. It is planned that W. E. Levis, U. E. Bowes, Amory Houghton and Glen W. Cole will retire from the Fiberglas board. Harold Boeschenstein will continue as Director, President and chief executive officer of Owens-Corning, but it is planned that he will resign from the board of Owens-Illinois Glass Company. Vacancies on the Fiberglas board will be filled by independent directors.

• Clyde Williams, Director of Battelle Memorial Institute, has received the honorary degree of Doctor of Engineering at the recent commencement ceremonies of the Michigan College of Mining and Technology.

For Improved Workability in Quality Glass

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TRADE-MARK REG. U. S. PAT. OFF.

THE Finest in Quality
POTASSIUM CARBONATE

FOR HIGH GRADE GLASS
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SOLVAY POTASSIUM CARBONATE

Dustless Calcined Potassium Carbonate 99-100% K_2CO_3

Granular Hydrated Potassium Carbonate 83-85% K_2CO_3

Acknowledged throughout the industry for:

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FOR SALE

GLASS PLANT, CHICAGO HEIGHTS, ILLINOIS

By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio, where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

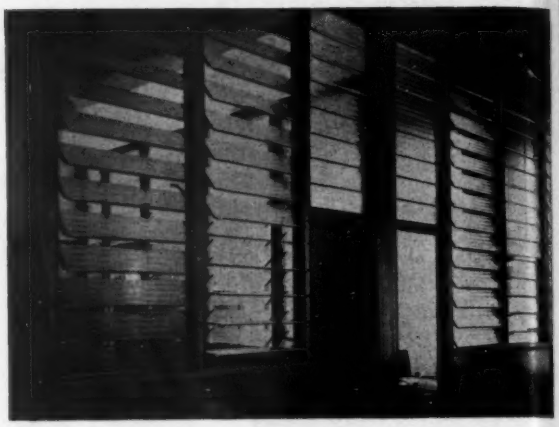
2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

Address all inquiries to

Owens-Illinois Glass Company
Attention: F. G. Morfoot
P. O. Box 1035, Toledo 1, Ohio



AUSTRALIAN GLASS LOUVRE WINDOWS TO RECEIVE GREATER DISTRIBUTION

Perfected in wartime by an Australian business man, a new system of window glazing has achieved annual sales in Australia of more than £A250,000 in three years, and will be introduced in the United States and other countries where patents have been taken out.

Known as the Cooper Louvre, it operates in much the same way as the venetian blind. It features glass slats which can be set to present a flat weatherproof surface like an ordinary frame window, or at any angle to the horizontal, to give free access to the outside air.

The system has attained such great popularity in Australia that it has virtually surplanted many other types of window, both for home use and for commercial and industrial buildings where maximum light and controlled ventilation are important.

An automatic locking device, which comes into action when the operating lever is moved to the "closed" position, provides effective protection from intrusion, and entry can only be gained by breaking several of the glass louvre-blades.

The frames which hold these blades are simple to install, and almost any handy man with a few tools can fasten them into position. The cost of replacing breakages is reduced to a minimum, as the small blades cost only a few pence each, while standard glass window panes are, by comparison, quite costly.

The Cooper Louvre had its genesis in the war years, when the possibility of enemy attack made black-outs imperative in the coastal regions of Australia. While the actual blackening of windows was undoubtedly efficient for that purpose, it excluded sunlight during daytime shifts in war factories and seriously lowered efficiency.

The Cooper Louvre readily lends itself to mass production, and Clifford E. Cooper, the designer, is confident that so handled it could be turned out at less than half the cost of any window known to him now in use in the building trade in America. Its low installation cost further emphasizes the economy angle.

The Cooper Louvre has been fully patented in the U. S. A., Great Britain, India and South Africa, the Argentine, Cuba, Chile, Costa Rica, Colombia, Ecuador, Panama, Paraguay and Venezuela.

• Air Reduction Company has established a new warehouse point in Tulsa, Oklahoma, to be located with Fidelity Transfer & Storage Co., 1540 East Fifth Street.

PERSONNEL CHANGES AT GLENSHAW

Several changes in officers and personnel of the Glenshaw Glass Company have been announced by S. B. Meyer, President of the firm. George W. Meyer, formerly Secretary of the company, has been elected Executive Vice President. The late Walter J. Meyer had been elected Secretary to succeed him, but due to his unfortunate death shortly after, the office has been filled by the appointment of William A. Meyer.

John W. Heinl, Jr., who has been an accountant with the company for many years, has been elected Comptroller and he and Mr. James E. Meyer have also been appointed Assistant Treasurers.

Dr. J. Howard Beck, son of the first president of the company, was elected Vice President. Robert M. Kay has become a member of the sales staff and will cover the territory formerly handled by the late Walter J. Meyer. Maurice Rabin has left the company to go into business for himself in North Carolina.

LACLEDE-CHRISTY ADDS NEW PRODUCTS TO LINE

Donald N. Watkins, President of Laclede-Christy Company has announced the addition of the following new products: silica brick, acid-proof brick and Ohio fire brick.

The marketing of these new products was made possible when the Laclede-Christy Company's Board of Directors approved a long term sales contract with the Davis Fire Brick Company and its affiliated companies located at Oak Hill, Ohio.

The Davis Fire Brick Company and its affiliates, the Ohio Fire Brick Company and the Cambria Clay Products Company, operate four plants which are equipped to manufacture a full line of all grades of fire brick, silica brick and acid-proof brick. All four plants are close to the "Sharon Conglomerate Quartz" deposit which contains over 98 per cent pure silica.

SYLVANIA ELECTRIC FORMS CANADIAN SUBSIDIARY

A Canadian subsidiary to manufacture fluorescent lamps and other lighting equipment has been formed by Sylvania Electric Products, Inc.

To be known as Sylvania Electric (Canada) Ltd., the new company has leased a plant from the city of Drummondville in the Province of Quebec. The building is being reconditioned by the city to the company's specifications.

F. J. Healy has been named President of the Canadian company; R. H. Bishop, Vice President; William O'Keefe, Secretary; and M. F. Balcom, Treasurer.

PENNSALT FORMS NEW SALES DISTRICT

The formation of a new sales district encompassing New York, New Jersey, Eastern Pennsylvania, Maryland and Delaware to provide more efficient service by its Special Chemicals Division has been announced by the Pennsylvania Salt Mfg. Company.

The new territorial arrangement, known as the Philadelphia District, has Joseph J. Duffy, Jr. as Manager of Sales. Horace F. McIntyre has been appointed District Sales Manager.

UNION-INDUSTRIES SHOW

Following the recent Union-Industries Show sponsored by the American Federation of Labor held in Cleveland, an open letter to the Employers of Members of the American Flint Glass Workers' Union from Harry H. Cook, President of the Union, described the Show as "the greatest of its kind in history".

Stressing the importance of American union-made glassware, the exhibit of the American Flint Glass Workers' Union displayed the product of union members representing a diversified line of attractive glassware. A technicolor moving picture was made of the Show sponsored directly by the American Federation of Labor. In addition, Movietone News is showing the Union's exhibit in many movie houses throughout the country.

It may be mentioned also that the publicity campaign being conducted by Catherine Blondin & Associates to popularize American glassware under the sponsorship of the American Glassware Association is also being contributed to by the American Flint Glass Workers' Union.

DIAMOND ALKALI APPOINTMENT

The election of W. E. Bittner as Vice President-Purchases of Diamond Alkali Company has been announced by Raymond F. Evans, President of the company. Mr. Bittner advances to his new position from the position of Director of Purchases which he has held for eight years.

During the many years that the firm's headquarters were in Pittsburgh, Mr. Bittner was an active member of the Pittsburgh Purchasing Agents Association. He served successively as a Director, Vice President and President of this group and during two different periods was a Vice President of the Sixth District Purchasing Agents Association and on the executive committee of the National Association of Purchasing Agents.

He joined the Diamond Alkali Company in 1916 and three years later was transferred to the purchasing department as a buyer. He subsequently became assisting purchasing agent, purchasing agent and then director of purchases.

• The Dominion Glass Co. has declared a dividend of 25 cents per share on the common stock and another dividend of 1¾% on the preferred stock, both payable July 15 to shareholders of record June 28, 1949.

14, 1916; 1,539,626, Bartlett, May 26, 1925; 2,008,567, Simonton, July 16, 1935; and 2,174,848, Stahmer, Oct. 3, 1939. Foreign Patents: 485,712, Germany, Nov. 5, 1929.

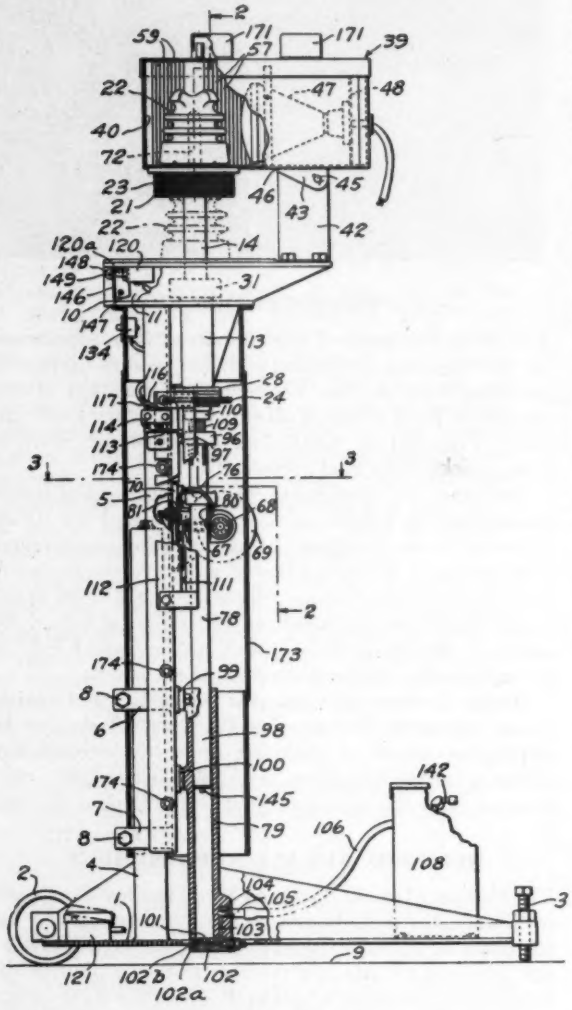


Fig. 10. Device for Inspecting Glass Articles.

Method of Preventing Blackening of Glass by Mercury Vapor. Patent No. 2,464,851. This patent was assigned to Corning Glass Works by James K. Davis. The invention has particular value in connection with the manufacture of low pressure mercury arc lamps where the glass should have good transmission for the germicidal wave length 254 mμ. Trouble has been encountered due to the blackening of the interior of the tube due to the contact with mercury vapor.

This patent increases the surface stability of borosilicate glass by treating it with water at a temperature of somewhere between 20 and 80° C. and thereafter heating the glass to as high a temperature as possible without distorting it.

By way of example, the following table shows the stabilities as loss in weight of a series of samples of one glass which were exposed to relative humidities of 50%, 75%, and 95%, respectively, at a temperature of about 50° C., and were then heated for five minutes at 750° C.

Hours Exposed	Loss in weight		
	mg./cm.² 50% RH	mg./cm.² 75% RH	mg./cm.² 95% RH
0	0.241	0.241	0.241
1	0.228	0.236	0.055
4	0.097	0.027	0.020
16	0.010	0.016	0.038
64	0.005	0.024	0.251

The following references are of record in the file of this patent: United States Patents: 2,286,275, Hood et al., June 16, 1942; 2,295,626, Beese, Sept. 15, 1942; 2,396,741, Jones et al., Feb. 20, 1945; 2,377,062, Adams, May 29, 1945; and 2,433,928, Sheldon, Jan. 6, 1948. Foreign Patents: 428,329, Great Britain, May 10, 1935.

Electrically Conducting Refractory. Fig. 11. Patent No. 2,467,144. John M. Mochel, the inventor, assigned this patent to Corning Glass Works. The refractory is useful particularly for contact with molten glass in connection with electrical melting.

Patent No. 2,244,777 discloses a refractory containing tin oxide and certain metals. This inventor has discovered that when such compounds including the metallic shrinking agent are heated to about 1200° C., they have an appreciable electrical conductivity and with the addition of 0.5 per cent or more of uranium oxide, the conductivity

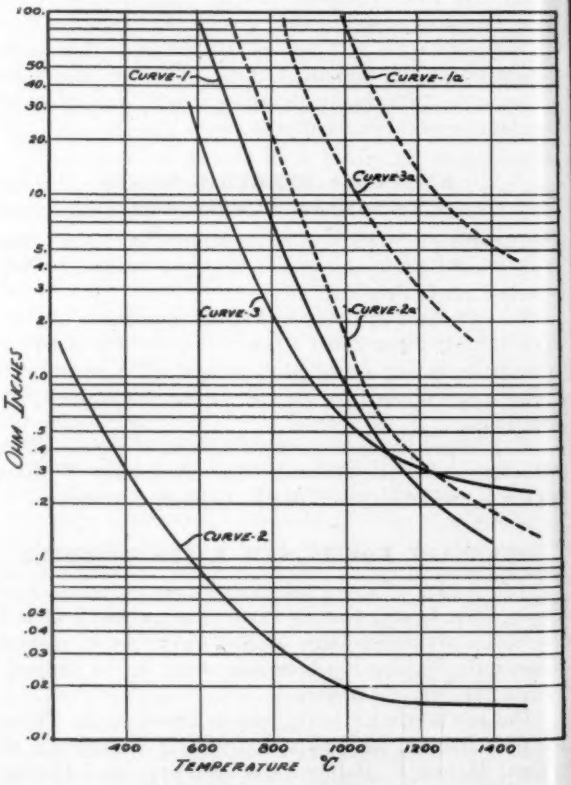


Fig. 11. Electrically Conducting Refractory.

is such that the material can be used in direct contact with molten glass.

The graph of Fig. 11 shows a series of curves representing the change in electrical resistance with change in temperature of the compositions which are given in per cent by weight in the following table. The values of the electrical resistance are plotted in a logarithmic scale and the curve numbers correspond with the numbers of several compositions. Curves 1, 2 and 3 are in accordance with this patent while the others are for comparison.

	1	1_a	2	2_a	3	3_a
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
SnO_2	89	100	96	98	58.0	59.3
UO_2	2	..	2	..	1.9	..
CuO	..	..	2	2	1.1	1.2
Zircon ...	..	..	..	..	39.0	39.5

The following references are of record in the file of this patent: United States Patents: 2,017,272, Meyer, Oct. 8, 1935; 2,244,777, Hood, June 10, 1941; and 2,256,033, McLachlan, Sept. 16, 1941. Foreign Patents: 368,270, Great Britan, Feb. 29, 1932; 368,272, Great Britain, Feb. 29, 1932; 368,770, Great Britain, Feb. 29, 1932; and 554,607, Germany, 1932.

Corhart Refractory. Patent No. 2,467,122. Corhart Refractories Company acquired this invention from Theodore E. Field, Louisville, Ky. The patent relates to heat cast refractories which may be in accordance with Patent No. 1,615,750 to Fulcher.

The following table gives four examples of compositions coming under this patent, which have proved satisfactory:

Melt	Al_2O_3	MgO	Na_2O	CaO	SiO_2	K_2O	Calculated Phases	
							Spinel	Beta alumina
A	77.0	21.2	1.3	.3	.2	..	75	25
B	83.0	14.0	2.7	.2	.1	..	50	50
C	88.6	7.2	4.0	.1	.1	..	25	75
D	82.4	14.0	1.3	.2	.1	2.0	50	50

A second table gives three other examples of compositions which come under another system but are still within the scope of the patent. The broad idea of the patent as stated in one of the claims is the provision of a heat cast refractory composed principally of beta alumina and magnesium spinel and in which the beta alumina lies between 20 per cent and 80 per cent and in which alkali oxide is present in an amount at least six times that of silica.

The following references are of record in the file of this patent: United States Patents: 2,075,694, Benner et al., Mar. 30, 1937; 2,154,069, Fessler et al., Apr. 11, 1939; and 2,261,639, Benner et al., Nov. 4, 1941.

• Edward J. Porter has been added to the sales staff of Vitro Manufacturing Company, according to a recent announcement. Mr. Porter will have headquarters in Chicago and will represent the firm in the states of Illinois, Michigan, Indiana and Iowa.

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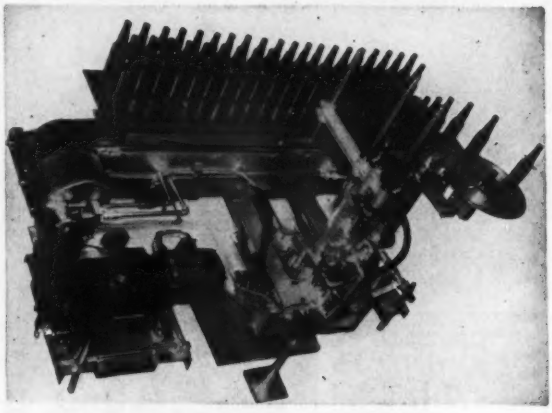

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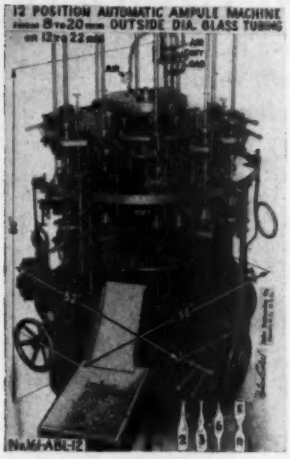

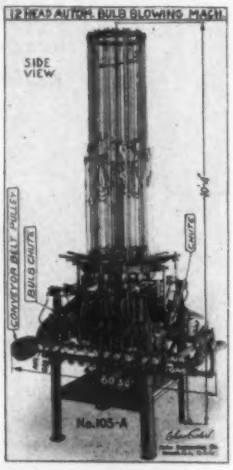

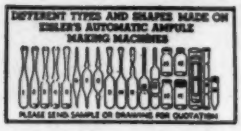

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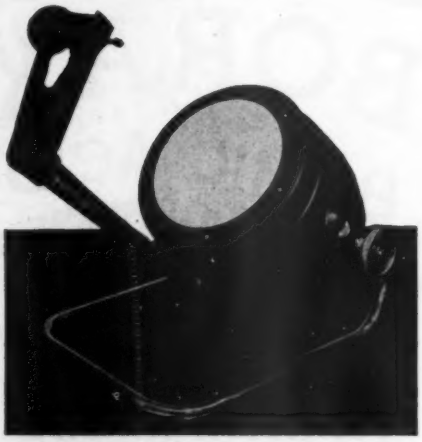

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"ALL GLASS" SEALED-BEAM HEADLAMPS . . .

(*Continued from page* 388)

at up to 1900 c.f.h. When the gas output is 1800 c.f.h., the amount of propane required per 1000 cu. ft. of the prepared gas is 314 cu. ft., or approximately 8.7 gallons. The generator is housed in a specially constructed building near the main plant (Figure 1) with the propane storage tanks placed nearby. The generator employs the air-steam reaction over a nickel compound catalyst in cracking and reforming the high-hydrogen gas from the propane. Three cracking tubes, each with a capacity of 500 c.f.h., are contained in the generator casing.

One of the two primary uses for the gas is to fuse the filament supporting wires or pegs into the back of the reflector (Figure 2). For this purpose an automatic machine consisting of a rotary table on which the reflectors are mounted on a number of locating jigs is used. Above each reflector is the necessary number of small torches up to which the reflectors are raised and then lowered at approximately 30-second intervals, the time required for fusing the three pegs (high beam, low beam and ground) into the back of each reflector. In this case the torches revolve around each peg to assure even heating and fusing. A circuit of the table completes this operation, from a loading and unloading station located opposite the side of the machine shown in Figure 2. Several reflectors are heated simultaneously so that reflectors are completed and delivered to the operator at intervals of approximately 6 seconds. As may be noticed from the illustration, the machine for this operation is rather intricate in order to provide the necessary movement of the torches, rotation of the table, control of combustion gas-oxygen mixture and amount supplied to the machine at the various stations.

After locating and attaching the filaments to the pegs, the reflectors are coated internally with aluminum which provides the bright reflecting surface for light projection. While this operation is similar to that recently disclosed*, in this case two reflectors are butted together face to face and the intervening space evacuated so that the vaporized aluminum is "thrown" against the inside surface of the two reflectors simultaneously.

The second major operation consists of fusing the lenses to the reflectors. For this operation an automatic machine somewhat similar to that used for the peg-attaching operation is employed, but in this machine the assemblies are rotated while the torches remain stationary. Here it is important that heating be extremely rapid not only to prevent softening of the glass except where desired, but also to prevent any burning off of the aluminum reflecting surface near the rim of the lamp (Figure 3.). Each circular burner consists of small torches closely spaced around its periphery so that numerous short hot flames are produced. The production rate is the same as for the peg sealing machine.

Following the joining of the reflector and lens, the lamps are evacuated, flushed with nitrogen, and evacuated again. This is repeated five times. After the final evacuation the lamp is filled with argon to a pressure of approximately two atmospheres. The evacuating and fill-

Materials & Methods, December, 1948, Pages 85 to 87.

ing tube is then sealed off and the exterior connecting terminals are then attached.

After assembly each lamp is light tested and at specified intervals lamps are selected at random and tested for conformance with light pattern and illumination specifications.

GLASS TECHNOLOGY EXPANDED AT UNIVERSITY OF TOLEDO . . .

(*Continued from page* 392)

The Museum's glass collection is recognized as one of the largest and most complete in the world. Its more than 3,500 pieces, largely the gift of Edward Drummond Libbey, include examples dating from 1500 B.C. through the contemporary era. To supplement the permanent collection, the Museum also arranges temporary exhibits on specific phases of glass and glassware consisting of pieces borrowed from individuals and other institutions.

Even though the University of Toledo's glass technology program is relatively new, the practical basis upon which it has been established, its attention to the actual conditions of glass technical problems and its close relationship and mutual cooperation with the glass manufacturing industry have given it world-wide attention. Inquiries have been received from Puerto Rico, Canada, England, Belgium and India.

L-O-F CHIEF INSPECTOR DIES

Alfred E. Louviaux, 72, former chief inspector of Libbey-Owens-Ford Glass Company, died recently. A member of the firm for 21 years, Mr. Louviaux retired in 1946.

Born in Belgium in 1877 and coming to the United States with his father in 1890, Mr. Louviaux began work in glass at an early age and took a job in Ford City, Pa., at the age of 14 years. He worked in plants in Creighton, Glassmere and Charleroi, Pa. For a time, he served as a window cutter for the American Window Glass Company. After working with the American Plate Glass Company, he went to Toledo in 1925 and joined the Libbey-Owens Sheet Glass Company.

His sons, Roy Louviaux, now general inspector for L-O-F, and Leon Louviaux, assistant inspector, are both following in the work of their father. Mr. Louviaux leaves his widow and five grandchildren.

M.I.T. TO INSTALL ELECTRON MICROSCOPE

The Division of Ceramics, Massachusetts Institute of Technology, has completed arrangements for the installation of an electron microscope in its laboratories for electron microscopy and electron diffraction work.

The installation represents a joint sponsorship by the Division of Ceramics, the Research Laboratory of Electronics and the Department of Physics. The design, installation and operation of the instrument will be under the supervision of Dr. B. F. Siegel.

The electron-optic system of the instrument will achieve a maximum theoretical power of resolution of the order of seven to ten Angstrom units. The design work is already under way, but it is estimated that an additional six months will be required to reach full operation.

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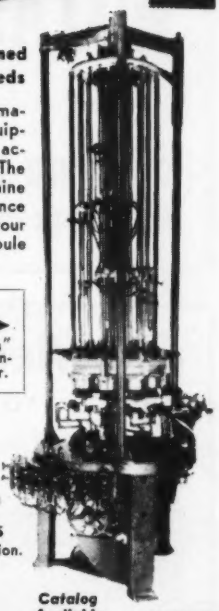

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MATHIESON CHEMICAL MAKES CHANGES IN SALES STAFF

Mathieson Chemical Corporation has announced several changes in its Sales Department executive staff as a result of the retirement of E. E. Routh, Vice President, Director of Sales. D. W. Drummond has been named Vice President, Director of Industrial Chemical Sales, and S. L. Nevins has been named Vice President, Director of Agricultural Chemical Sales.

All heavy chemicals, including sulfuric acid, will be handled by the Industrial Chemical Sales Department. All agricultural chemicals, which have been added as the result of recent acquisitions of Southern Acid and Sulphur Company and Standard Wholesale Phosphate & Acid Works, Inc., will be under the direction of the Agricultural Chemical Sales Department.

Other appointments announced were J. O. Logan as Sales Manager, Industrial Chemicals; R. J. Quinn, Assistant Sales Manager, Industrial Chemicals; L. P. Thomas, Southwestern Sales Manager, Industrial Chemicals; J. S. Whittington, Sales Manager, Agricultural Chemicals.

JOINT CERAMIC SOCIETY MEETING

A joint technical session of the Physical Society of Pittsburgh and the Pittsburgh Section of the American Ceramic Society was recently held at the Mellon Institute.

Two of the speakers at the all-day session were H. R. Lillie, Corning Glass Works research physicist, who discussed the topic, "Measurement of Glass Viscosities at Higher Temperatures", and Dr. S. D. Stookey, Corning Glass Works research chemist, who gave a talk and demonstration on "Photosensitive Glass".

The session also marked the election of officers for the Pittsburgh Section of the American Ceramic Society at which D. Owen Evans, of CGW's Charleroi Plant, assumed the chairmanship.

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